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UMASS/AMHERST

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FORTY-SIXTH

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

STATE BOARD OF AGRICULTURE,

TOGETHER WITH THE

ELEVENTH ANNUAL REPORT OF THE HATCH EXPERI-
MENT STATION OF THE MASSACHUSETTS
• AGRICULTURAL COLLEGE.

1898.

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STATE BOARD OF AGRICULTURE, 1899.

Members ex Officio.

HIS EXCELLENCY ROGER WOLCOTT.

HIS HONOR W. M. CRANE.

HON. WM. M. OLIN, *Secretary of the Commonwealth.*

H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*

C. A. GOESSMANN, PH.D., LL.D., *Chemist of the Board.*

WM. R. SESSIONS, *Secretary of the Board to July 1, 1899.*

JAMES W. STOCKWELL, *Secretary of the Board from July 1, 1899.*

Members appointed by the Governor and Council.

	Term Expires
FRANCIS H. APPLETON of Lynnfield, ...	1900
DWIGHT A. HORTON of Northampton, ...	1901
JAMES S. GRINNELL of Greenfield, ...	1902

Members chosen by the Incorporated Societies.

<i>Anesbury and Salisbury (Agr'l and Hort'l),</i>	{ F. W. SARGENT of Amesbury, ...	1900
<i>Barnstable County,</i>	JOHN BURSLEY of West Barnstable, ...	1901
<i>Berkshire,</i>	WESLEY B. BARTON of Dalton, ...	1900
<i>Blackstone Valley,</i>	SAMUEL B. TAFT of Uxbridge, ...	1900
<i>Bristol County,</i>	{ E. M. THURSTON of Swansea (P. O. South Swansea), ...	1902
<i>Deerfield Valley,</i>	HENRY A. HOWARD of Colrain, ...	1902
<i>Eastern Hampden,</i>	O. P. ALLEN of Palmer, ...	1900
<i>Essex,</i>	JOHN M. DANFORTH of Lynnfield, ...	1902
<i>Franklin County,</i>	F. L. WHITMORE of Sunderland, ...	1901
<i>Hampshire,</i>	GEO. P. SMITH of Sunderland, ...	1901
<i>Hampshire, Franklin and Hampden,</i>	EDWARD E. WOOD of Northampton, ...	1900
<i>Highland,</i>	C. K. BREWSTER of Worthington, ...	1902
<i>Hillside,</i>	{ ALVAN BARRUS of Goshen (P. O. Lithia), ...	1902
<i>Hingham (Agr'l and Hort'l),</i>	EDMUND HERSEY of Hingham, ...	1900
<i>Hoosac Valley,</i>	{ N. B. BAKER of Savoy (P. O. Savoy Centre), ...	1900
<i>Housatonic,</i>	CHARLES B. BENEDICT of Egremont, ...	1900
<i>Man'sf'r's Agr'l (No. Attleborough),</i>	OSCAR S. THAYER of Attleborough, ...	1900
<i>Marshfield (Agr'l and Hort'l),</i>	WALTON HALL of Marshfield, ...	1900
<i>Martha's Vineyard,</i>	EVERETT A. DAVIS of West Tisbury, ...	1901
<i>Massachusetts Horticultural,</i>	E. W. WOOD of West Newton, ...	1900
<i>Massachusetts Society for Promoting Agriculture,</i>	{ N. I. BOWDITCH of Framingham, ...	1900
<i>Middlesex North,</i>	{ JOSHUA CLARK of Tewksbury (P. O. Lowell), ...	1901
<i>Middlesex South,</i>	{ ISAAC DAMON of Wayland (P. O. Cochituate), ...	1902
<i>Nantucket,</i>	J. S. APPLETON of Nantucket, ...	1900
<i>Oxford,</i>	J. W. STOCKWELL of Sutton, ...	1901
<i>Plymouth County,</i>	{ AUGUSTUS PRATT of North Middleborough, ...	1902
<i>Spencer (Far's and Mech's Assoc'n),</i>	J. ELTON GREEN of Spencer, ...	1901
<i>Union (Agr'l and Hort'l),</i>	ALMON W. LLOYD of Blandford, ...	1901
<i>Weymouth (Agr'l and Ind'l),</i>	QUINCY L. REED of South Weymouth, ...	1900
<i>Worcester,</i>	J. LEWIS ELLSWORTH of Worcester, ...	1902
<i>Worcester East,</i>	W. A. KILBOURN of South Lancaster, ...	1900
<i>Worcester North-west (Agr'l and Mech'l),</i>	{ T. H. GOODSPEED of Athol (P. O. Athol Centre), ...	1901
<i>Worcester South,</i>	C. D. RICHARDSON of West Brookfield, ...	1901
<i>Worcester County West,</i>	CHAS. A. GLEASON of New Braintree, ...	1902

THE FORTY-SIXTH ANNUAL REPORT
OF THE
SECRETARY
OF THE
BOARD OF AGRICULTURE.

*To the Senate and House of Representatives of the Commonwealth of
Massachusetts.*

The season of 1898 opened about a week later than the normal, with cold weather and excessive moisture in April, and at the end of May it was still about a week late. Mowings were everywhere in first-class condition and pastures secured a remarkably good start. Fall seeding wintered well in almost every case and made a good growing start. The fruit bloom was, on the whole, about average. But little damage from insects was reported. Spraying against insects was not practised as much as it should have been. Strictly first-class help was, as always, hard to secure. Wages averaged about \$17 to \$18 per month with board and about \$1.25 per day without board. No marked changes in the acreage of farm crops were reported and no new enterprises in agriculture.

In June insects did not appear to be doing any notable damage, except in isolated cases. Indian corn looked fairly well, though rather backward, with about the usual acreage. Haying had not generally begun, but the crop was generally spoken of as very heavy indeed. The acreage of early potatoes was greatly above the average and the crop generally promised very well. Early market-garden crops were rather late, but those harvested made good yields, with prices ruling about as usual. Dairy products showed a slight

increase in quantity, with prices about as usual. Pastures were never in better condition. Strawberries were yielding the heaviest crop for years, but the prices were most discouraging. Plums and cherries looked well, but pears were a little off. Apples did not set well and were much below the average. Peaches did not indicate an average crop.

July continued to be remarkably free from insects. Indian corn came forward very rapidly and was generally in good condition. The use of silos was believed to be steadily increasing. The hay crop was everywhere reported as very good indeed and haying was practically completed. The quality of the crop was excellent and it was generally secured in prime condition. The heavy hay crop and the good condition of pastures both operated to reduce the acreage devoted to forage crops, but they were generally in good condition. Market-garden crops were generally in good condition and promising well. Early potatoes were not generally dug, but the crop promised to be rather light; prices generally ruled high. Apples and pears both promised light crops; plums fair and quinces good; grapes promised well. Pastures suffered somewhat, but were still in good condition. Rye, oats and barley were all about average crops.

Indian corn was looking well as a whole at the end of August, though it was backward in some sections. The rowen crop promised to equal, or even exceed, the phenomenal crop of the previous year. Late potatoes promised to be a better crop than the previous year, but were still hardly up to the normal. Potato blight was quite common and rot was also reported in some sections. The tobacco crop was reported as unusually good, and cutting was practically completed by the end of the month. Apples promised a small crop. Pears were also light. Peaches were below the average, but grapes promised well. Cranberries did not promise well, as a rule. Pastures were in fine condition, seldom, if ever, having been better. Oats and barley were hardly normal crops where raised for grain, but as forage crops were highly satisfactory. Poultry keeping was generally regarded as profitable, but is a side issue except in the south-eastern portion of the State.

The warm, dry weather of the early part of September brought corn forward very rapidly, and the absence of killing frosts enabled it to ripen up well where late. Rowen was perhaps the best crop ever cut. Fall feed was also in prime condition in most sections. Less than the usual amount of fall seeding was done, usually because of excessive moisture, but that which was put in was generally in good condition. Onions were rather less than an average crop, there being a marked shortage in the regions of principal production. Potatoes were not an average crop, and there were many complaints of rot and of the tubers being small and few in the hill. Root crops were generally in good condition. Celery hardly promised a full crop. Other late market-garden crops were doing well. Apples were very uneven, but the crop was better than was anticipated. Pears generally yielded well. Peaches did better than usual and brought good prices. Plums yielded well, but rotted badly. Cranberries were hardly an average crop, but still were better than the promise of the previous month. Grapes generally showed good yields.

Correspondents in their returns late in October reported root crops in good condition, with yield rather more than average. Farm stock was generally reported as being in prime condition. Prices for farm crops were thought by many to have fallen off from former years. Out of 156 replies, 98 spoke of prices as average, 18 as higher than usual and 40 as lower than usual. There was considerable diversity of opinion among correspondents as to crops which had proved most profitable. Fifty-six considered hay to have been among the most profitable crops; 43, corn; 36, apples; 29, potatoes; 10, tobacco; 8, fruit; 7, tomatoes; and the rest scattering. Sixty-two correspondents spoke of potatoes as among the least profitable crops; 22, hay; 14, cabbages; 11, strawberries; 10, apples; 10, corn; 7, onions; 7, squashes; 6, fruit; and the rest scattering. It seems probable, in the light of the returns referred to above, that the season was rather more profitable than usual. Nearly all crops yielded unusually well, thus making up somewhat for the prevailing low prices of most farm produce. Eighty-two of the 154 correspondents expressing an opinion as to

the profits of the season regarded it as profitable, 25 as an average one for profit, 20 as fairly profitable and 27 as unprofitable. In Bristol County, where the growing of strawberries is an important item, the correspondents were nearly unanimous that the season had not been profitable, owing largely to the low prices received for fruit.

MASSACHUSETTS WEATHER, 1898.

[Compiled from data furnished by the New England Weather Service.]

January was about normal in temperature and considerably above the average in precipitation. There was an unusually severe storm from January 31 to February 1, which was generally considered to have been more severe than the "blizzard" of March, 1888. Heavy snow fell all night, and on the morning of February 1, Massachusetts, with the rest of New England, was completely snowbound. Railroad travel was completely at a stand-still for twenty-four hours, and many vessels were wrecked along the coast, nearly two-score mariners losing their lives.

February was above the normal in both temperature and precipitation, but the snowfall was generally moderate throughout the State. The first part of the month was very cold, but later in the month the weather was mild. There was much cloudiness and rain and an unusually severe hail and sleet storm on the 19th to 22d. In the central southern portion of the State much damage was done by ice forming on the trees and stripping them of their branches.

March was remarkably mild and pleasant, and at the end of the month the ground was generally in good tillable condition, with the snow gone and frost almost entirely out. The season was considered to be two or three weeks in advance of the average. The precipitation was deficient and the snowfall very light, while the month was singularly free from severe storms and gales. The temperatures were at 60° or above on several days, and the minimum values were unusually high.

The prevailing weather of April was most unfavorable for agricultural pursuits. The remarkably fine weather of March presaged an early spring, but April in some parts of the

State was the coldest and wettest on record, and all preliminary farm work was greatly retarded. The average daily temperature deficiency was about 3° . The precipitation was excessive and the number of rainy days large. The latter part of the month was particularly stormy, with precipitation in some part of the State on nearly every day.

May opened with pleasant, mild weather, but by the 3d stormy conditions again prevailed. From the 6th to the 15th the conditions were much more favorable, and practically no precipitation occurred. Several mornings were quite cool and frosty. The weather during the third week of the month was generally favorable, with more sunshine. The last week of the month was remarkable for the amount of cloudiness and rain, caused by the slow passage of a storm up the Atlantic coast. No high gales accompanied this storm, but the temperature remained low, with much fog and thick weather along the coast. Taken together, April and May were most unfavorable for farming operations.

June opened unfavorably for the farmer in all parts of the State except in the extreme western counties. The total amount of precipitation during the first week was not excessive, but the continued cloudiness retarded the growth of crops and interfered with farm work in general. The week ending with the 13th was almost perfect for crop development. The week ending the 20th was also most favorable. Light frosts occurred, but no damage was reported. Bright, sunny days were the rule for the last week. The month was practically normal in temperature, but a slight deficiency in precipitation was noted.

July was a month of extremes in temperature, ranging from a maximum of about 98° on the 3d to a minimum of 48° on the mornings of the 10th and 12th inclusive. In some places light frost was reported on the 12th, but no damage resulted. The precipitation was deficient during the first half of the month, but later numerous showers brought the amount up to the average. There was a very severe thunderstorm, with very heavy rainfall, in east central Massachusetts during the afternoon of the 19th. This storm did much good, as the ground was beginning to feel the lack of rain. The last few days of the month were generally cloudy,

with scattered light showers. The winds during the month were of moderate velocity and mostly from the south-west.

The weather conditions of August were extremely disagreeable. The temperature ranged considerably above the normal and the humidity was excessively high, the last ten days of the month being particularly disagreeable. The rainfall was also excessive and the local thunderstorms were numerous and severe. The storm of the 17th was particularly severe in Boston and the immediate vicinity. The monthly rainfall was considerably less in western Massachusetts than in the central and eastern portions of the State. The average temperature at Boston for the first twenty-five days was 73.2° , — between 3° and 4° above the normal. The winds were of moderate velocity and mostly from the south-west. The amount of cloudiness was above the average.

One of the longest and most sustained warm-weather periods on record prevailed during the first seven days of September. The temperature was not remarkably high, but, after hot days, the nights were warm and oppressive, and the average daily humidity was considerably above the normal. Fresh north-west winds on the 8th brought cooler, pleasant weather, which lasted until the 17th, when an area of low barometer brought a short spell of moist, warm weather. This was followed with cooler weather, culminating in light frosts on the mornings of the 21st and 22d. Gloomy weather and temperatures below the normal were prevalent on the 24th and 25th, but the closing days of the month were warmer and more propitious. Altogether, September was extremely favorable for harvesting.

October opened with fine, generally clear weather and temperatures considerably above the normal. This condition continued until the 5th, when it was interrupted by a heavy rain-storm and a decided decline in temperature. The second storm occurred on the 8th, and was light in force. Clear weather then prevailed until the 12th, which was showery. Rain again occurred on the 15th, followed by three days of pleasant skies. The latter half of the month witnessed several fine days, but heavy rain-storms were also quite frequent. The temperature ranged at nearly normal figures from the 6th to the 9th, inclusive, and the morning of

the 10th was quite cool, with heavy and killing frosts in the interior. From the 13th to the 19th the range of mercury was slightly below the usual figures, the 17th and 18th being the coolest days, when the thermometer fell almost to the freezing point. For the entire month, however, the temperature was some 80° in excess of the normal. The maximum temperatures of the month were registered generally on the 3d and 4th, and averaged about 85° . As a whole, the month was favorable for out-door work, and outstanding crops suffered little damage from frosts or storms.

The weather for November marked the change from autumn to the winter season with more than usual emphasis, although the mean conditions of temperature and precipitation showed no remarkable departures from the monthly normals. The highest temperatures were recorded during the first few days of the month, the maximum being 63° , at Boston, Concord and Vineyard Haven. The lowest temperatures occurred principally on the 26th, 28th and 29th, ranging from 8° at Monson to 28° at Nantucket. The average precipitation was large. The great storm of the 26th-27th obscured all other meteorological features of the month. This storm resulted from the union of two disturbances, one moving from the Great Lakes, the other coming up the Atlantic coast, and meeting off the New Jersey coast. The combined storms then moved to the New England coast, the pressure falling to about 29.40 inches. On the islands of Nantucket and Martha's Vineyard the precipitation was mostly in the form of a pouring rain, while on the mainland heavy, drifting snows prevailed. The storm reached its greatest force in the forenoon of the 27th, and its entire duration was about thirty hours. North to east gales of extreme violence swept over the State. For many hours the wind maintained a 50-mile velocity, the maximum, 78 miles per hour from the north, occurring at Woods Hole. Not in the history of the present generation has there been such a record of devastation and death as that which was disclosed after the passage of this storm.

December was characterized by a smaller amount of rain and snow than usual, and rapid changes between the extremes of heat and cold. The temperature was below the average.

The maximum temperature, 58° , at Boston on the 30th, was the lowest in the past decade of years, except the years of 1890 and 1892, which gave the same maximum. The highest temperature was almost uniformly registered on the 30th. The periods of low temperature were distinctly marked, and the lowest of the month occurred universally on the 14th. On that morning the range of temperature was from -10° to -16° in the interior and western part of the State to about zero on the eastern coast, and 2° to 10° above zero on the south-eastern coast and the islands. This cold wave was followed within twenty-four to thirty hours by a rise of from 30° to 50° , and this rapid recovery was in turn followed by a fall of as many degrees during the night of the 15th–16th. For several days thereafter the daily minima were low, with strong daily ranges. The storms of the month were nearly all general, and they came in regular periods. The first, that of the 4th–5th, was a severe storm in central and western portions. Violent easterly winds unroofed buildings, toppled over chimneys and blew down large trees. The second storm period was on the 12th and 13th, the precipitation falling as snow. The third period comprised the 20th to the 23d, resulting in light snow on the 20th and moderate to heavy rainfalls on the 22d and 23d. The fourth period included practically the last five days of the month, although the precipitation was not general until the 31st. The storm began as rain and turned to snow. The total snowfall of the month was in general less than 10 inches, — much less than the average.

METEOROLOGICAL OBSERVATORY OF THE HATCH EXPERIMENT STATION (MASSACHUSETTS AGRICULTURAL COLLEGE), AMHERST.

ANNUAL SUMMARY FOR 1898.

Pressure (in Inches).

Maximum reduced to freezing, 30.45,
March 26, 7 A.M.
Minimum reduced to freezing, 28.69, February 19, 6 A.M.
Maximum reduced to freezing and sea level, 30.76, March 26, 7 A.M.
Minimum reduced to freezing and sea level, 29.01, February 16, 6 A.M.
Mean reduced to freezing and sea level, 30.008.
Annual range,* 1.75.

*Air Temperature (in Degrees F.).**

Highest, 96.5, July 3, 3 P.M.
Lowest, — 19.0, February 3, 6 A.M.
Mean, 47.5.
Mean of means of max. and min., 47.5.
Mean sensible (wet bulb), 45.2.
Annual range, 115.5.
Highest mean daily, 81.6, July 3.
Lowest mean daily, — 2.0, January 30.
Mean maximum, 57.7.
Mean minimum, 37.4.
Mean daily range, 20.3.
Greatest daily range, 40.0, February 3.
Least daily range, 2.5, April 5.

Humidity.

Mean dew point, 4.16.
Mean force of vapor, .426.
Mean relative humidity, 79.8.

Wind. — Prevailing Direction, West, or S. 86° W. Summary (Per Cent).

South, 15.
West, 13.
North-west, 12.
South-south-west, 11.
South-west, 10.
North, 9.
Other directions, 30.
Total movement, 48,425 miles.
Greatest daily movement, 675 miles, November 27.

Least daily movement, 4 miles, January 18.
Mean daily movement, 133 miles.
Mean hourly velocity, 5.5 miles.
Maximum pressure per square foot, 30.5 pounds = 78 miles per hour on September 7, 1.30 P.M., S.W.

Precipitation (in Inches).

Total precipitation, rain or melted snow, 53.89.
Number of days on which .01 or more rain or melted snow fell, 135.
Snow total in inches, 69.5.

Weather.

Mean cloudiness observed, 60 per cent.
Total cloudiness recorded by sun thermometer, 2,317 hours = 52 per cent.
Number of clear days, 78.
Number of fair days, 138.
Number of cloudy days, 149.

Bright Sunshine.

Number of hours recorded, 2,159 = 48 per cent.

Dates of Frosts.

Last, April 27.
First, September 21.

Dates of Snow.

Last, April 6.
First, November 24.
Total days of sleighing, 85.

Gales of 50 or More Miles per Hour.

January 3, 67 miles, N.W.; January 24, 56 miles, N.W.; March 20, 56 miles, W.; May 8, 60 miles, N.E.; July 30, 59 miles, S.W.; August 23, 51 miles, N.W.; September 7, 78 miles, S.W.; November 11, 55 miles, W.; November 27, 62 miles, N.; December 4, 75 miles, W.; December 5, 73 miles, E.S.E.; December 31, 50 miles, N.N.E.

J. E. OSTRANDER, *Meteorologist.*
A. C. MONAHAN, *Observer.*

* Temperature in ground shelter.

MASSACHUSETTS CROP REPORTS.

The publication of monthly crop reports or bulletins was continued in 1898, and six in all were issued (May–October), aggregating 229 pages of printed matter. Twenty-five hundred copies of Nos. 1, 4, 5 and 6, 2,700 copies of No. 3 and 2,800 copies of No. 2 were printed and distributed.

The special subjects treated were: Bulletin No. 1, "Nature's foresters," by E. H. Forbush; Bulletin No. 2, "The San José scale in Massachusetts," by A. H. Kirkland, M.S.; Bulletin No. 3, "Catch-crops," by Prof. Wm. P. Brooks; Bulletin No. 4, "Tuberculosis and the milk supply," by Geo. M. Whitaker, A.M.; Bulletin No. 5, "Milk and cream," by Dr. J. B. Lindsey; and Bulletin No. 6, "Stable disinfection," by Prof. Jas. B. Paige. These special articles will be found printed on pages 279–377 of this volume.

PUBLICATIONS.

This office issued the following publications during the calendar year 1898:—

	Pages.	Number.	Date of Issue.
Pamphlet descriptive of the brown-tail moth.	7	10,000	March 22.
Agriculture of Massachusetts, 1897, .	826*	15,000	April 23.
Crop Bulletin No. 1, May, . . .	40	2,500	June 4.
Crop Bulletin No. 2, June, . . .	38	2,800	July 2.
Crop Bulletin No. 3, July, . . .	39	2,700	August 1.
Crop Bulletin No. 4, August, . .	34	2,500	September 2.
Crop Bulletin No. 5, September, .	39	2,500	October 1.
Crop Bulletin No. 6, October, . .	39	2,500	November 5.
Regulations of Board, speakers and subjects, farmers' institutes.	14	600	November 26.

* Including tenth annual report of the Hatch Experiment Station, 133 pages.

LEGISLATIVE APPROPRIATIONS FOR AGRICULTURAL PURPOSES.

OBJECTS FOR WHICH APPROPRIATED.	1896.		1897.		1898.		1899.
	Appropriated.	Used.	Appropriated.	Used.	Appropriated.	Used.	Appropriated.
Bounties to societies, ...	\$21,000 00	\$20,084 12	\$21,000 00	\$20,344 68	\$21,000 00	\$19,933 17	\$19,800 00
Travelling and necessary expenses of the Board, ...	1,900 00	1,600 03	1,900 00	1,527 92	1,900 00	1,291 27	1,900 00
Travelling and necessary expenses of the secretary, ...	500 00	492 42	500 00	500 00	500 00	500 00	500 00
Incidentals in office of secretary, ...	800 00	800 00	800 00	800 00	800 00	800 00	800 00
Salaries of secretary and clerks, ...	5,300 00	5,300 00	5,300 00	5,300 00	5,500 00	5,500 00	5,500 00
Dissemination of useful information in agriculture by means of lectures or otherwise, .	2,800 00	2,800 00	2,800 00	2,800 00	2,800 00	2,800 00	2,800 00
Printing 15,000 copies of the "Agriculture of Massachusetts,"	5,473 86	5,473 86	6,100 13	6,100 13	5,748 69	5,748 69	* 6,000 00
Collecting and circulating information relative to abandoned farms, ...	1,000 00	283 00	† 727 00	419 54	—	—	—
Carrying forward work of Dairy Bureau, .	7,000 00	6,998 95	7,000 00	7,000 00	7,000 00	6,389 35	7,000 00
Salary of executive officer of Dairy Bureau, .	500 00	500 00	500 00	500 00	500 00	500 00	500 00
Salary of assistant in work of Dairy Bureau, .	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00
Nails or spikes for marking shade trees for preservation, ...	200 00	133 34	200 00	47 17	200 00	—	200 00
Aggregates, ...	\$47,673 86	\$45,665 72	\$48,027 13	\$46,539 44	\$47,148 69	\$44,662 48	\$46,200 00

* Estimated.

† Unexpended balance.

Also the Legislature of 1898 made the following regular annual appropriations: for maintaining an agricultural experiment station at the Massachusetts Agricultural College, \$10,000; for the said college, for free scholarships, \$10,000; for the said college, for labor fund and extra instruction, \$10,000; for travelling and other necessary expenses of the trustees of the said college, \$800; and to defray expenses of collecting and analyzing samples of concentrated commercial feed stuffs, \$1,200. The Legislature also appropriated for the said college, for a veterinary laboratory and stable hospital in connection therewith, for apparatus and material for the chemical department, and for a building and equipment for the investigation of dairy problems, the sum of \$28,000; also \$200,000 for carrying forward the work of extermination of the gypsy and brown-tail moths. The appropriations thus listed amount to the sum of \$307,148.69.

LEGISLATION.

The legislation of 1898 having reference to the Board of Agriculture or to the agricultural societies was "An act making appropriations for sundry agricultural expenses" (Acts of 1898, chapter 22); "An act making an appropriation for continuing the work of extermination of the gypsy moth" (Acts of 1898, chapters 31 and 290); "An act to establish the salary of the first clerk of the secretary of the State Board of Agriculture" (Acts of 1898, chapter 459); "An act to require the State Board of Agriculture to take charge of the work of exterminating the brown-tail moth" (Acts of 1898, chapter 544); "Resolve to provide for the payment of certain expenses of the annual convention of the Farmers' National Congress, to be held in the year 1899" (Resolves of 1898, chapter 31); and a "Memorial relative to the extermination of the gypsy moth."

SPIKES AND WASHERS.

The appropriation for the purchase of M spikes and washers was the usual \$200; but, the supply left over from the previous year being ample, no part of the appropriation was expended.

Spikes and washers were supplied during the year to the city of Springfield and to the towns of Andover, Concord, Erving, Hardwick, Oakham, Princeton, Sharon, Sterling, Swampscott, Townsend, Ware and Wilmington. Since the work of supplying these spikes was begun, Dec. 26, 1891, five cities and seventy-three towns have availed themselves of the provisions of the act. In all there have been furnished approximately 170,000 spikes, with accompanying washers, during the period named.

SCALES OF POINTS.

As in past years, scales of points or score cards have been supplied when called for. Quite a quantity of the cards still remains in the office of the secretary, subject to call.

ABANDONED FARMS.

The last edition of 1,500 copies of the catalogue of these farms was printed in December, 1897, and has sufficed to supply the demand during the year 1898. Very few catalogues remain on hand. If the work is to be continued, it will be necessary for the Legislature to make a further appropriation.

FARMERS' INSTITUTES.

During the calendar year of 1898 125 farmers' institutes were held under the auspices of this Board. These meetings were addressed by 84 different speakers, who made an aggregate of 161 appearances. To say that they delivered 161 lectures would be misleading, as on several occasions some of them delivered two lectures at one institute. The speakers at these 125 institutes were selected from a printed list of more than 60 available lecturers, composed of professors in the agricultural colleges of this and neighboring States, experiment station workers, specialists in the various branches of agriculture, successful farmers, market gardeners, poultry men, fruit growers and dairymen.

An examination of the reports of the several institutes shows that professors in agricultural colleges and experiment station workers addressed farmers' institutes on 39 different occasions; that institute workers of generally recognized

ability and more than local reputation, in fact, institute workers of the first class, addressed institutes on 68 different occasions; and that there were also 53 addresses by local speakers, not necessarily men of less experience or ability than those above referred to, but men whose experience in institute work has been mainly local, and who are as yet of only local reputation.

After the institute season was quite well advanced, the idea was conceived of sending out blanks on which the secretaries of the various agricultural societies were to report the number of persons attending each institute. As this was a new departure, and was not adopted at the beginning of the year, complete returns in regard to attendance were not received; but it can safely be said that the attendance reported was most gratifying, and, indeed, unexpected. There were received returns of attendance at 95 institutes, the average attendance being 96. The largest attendance reported was 450 and the smallest 4. The society making the latter report showed an attendance at its 3 institutes of 9, 4 and 10. These 3 meetings cost the State nothing, as the society did not apply for speakers; but this can hardly excuse it for the holding of such perfunctory institutes. In comparison with these 3 institutes, it is possible to report two series where the attendance was 200, 225 and 250. Of the 95 returns of attendance received, 2 were between 400 and 500; 8, between 200 and 300; 28, between 100 and 200; and 57, less than 100. Reports of attendance of less than 50 were usually accompanied by explanatory notes, calling attention to some unusual condition, such as bad roads, a severe storm, etc. This would seem to show that such attendances were regarded as unusual, so much so as to seem to the several secretaries to call for an explanation and excuse.

Lecturers were furnished by this office for 98 institutes, at a total cost of \$1,469.94 for services and expenses, — an average of \$14.99 per institute. All of the societies but the Massachusetts Society for Promoting Agriculture, which holds no institutes, held the required 3, and 7 held 4 or more. As in past years, institutes were arranged for through this office in certain localities where conditions

seemed to warrant. These institutes, of which there were 11, were not held under the auspices of an incorporated society, but of some other agricultural organization. Perhaps it should be said in this connection that, while the holding of such institutes is not particularly encouraged, it is realized that there are conditions or circumstances which justify such action on the part of this office. The money paid lecturers being furnished by the State, it is conceded that all portions of the State are entitled to equal consideration in its expenditure.

DAIRY BUREAU.

The work of the Dairy Bureau is set forth in its report to the Legislature (Pub. Doc. No. 60), which report will be found printed on pages 381-407 of this volume. There has been no change in the personnel of the Bureau during the past year.

GYPSY MOTH.

The sum of \$200,000 was appropriated by the Legislature of 1898 for the continuation of the work of exterminating this pest, except that by a later law \$10,000 of this sum must be used in brown-tail moth work. The report of the committee in charge, with appendix, will be found printed on pages 411-481 of this volume.

BROWN-TAIL MOTH.

By chapter 544 of the Acts of 1898, the State Board of Agriculture was required to take charge of the work of exterminating the brown-tail moth. By this act the Board of Agriculture was "vested with all the powers now conferred upon it by law in exterminating the gypsy moth," and was given authority to "expend of the money heretofore appropriated for the extermination of the gypsy moth a sum not exceeding \$10,000." By this act the law of 1897 requiring local authorities to suppress the brown-tail moth was repealed. In March, 1898, an illustrated bulletin of information on the brown-tail moth was issued by this office, and several thousand copies were supplied citizens in the infested districts.

AGRICULTURAL COLLEGE.

The report of the examining committee of the Agricultural College will be found printed on pages 237-247 of this volume. An essay on "The Massachusetts Agricultural College: its criticisms; its benefits," by C. K. Brewster, will be found printed on pages 264-273 of this volume. The eleventh annual report of the Hatch Experiment Station of the college is by law bound with the report of the secretary of the Board of Agriculture in this volume.

AGRICULTURAL SOCIETIES.

The returns of the societies will be found printed on pages 567-594 of this volume. A summary, contrasting the totals of 1896, 1897 and 1898, is printed on page 594 of this volume.

The Massachusetts Society for Promoting Agriculture holds no fair. By special act of the Legislature, this society has a representative on this Board, and is thus excused from holding fairs and paying premiums. The Worcester Agricultural Society held no fair by itself in 1898, but it offered and paid the required amount of premiums (\$600) in connection with the Worcester Horticultural Society and the Worcester South, Worcester East and Oxford agricultural societies in premiums on crops and on herds of milch cows, which were examined on premises of owners, thus complying with the law, and entitling it to representation on the Board of Agriculture. All of the other societies represented on the Board have held annual fairs. Most of them were favored with fine weather for their annual gatherings, and they were generally well attended. Many of the societies report unusual prosperity, while a few are running behind financially.

AGRICULTURAL DIRECTORY.

A directory of the agricultural organizations in the Commonwealth, with officers for 1899. will be found printed on pages 597-612 of this volume.

MEETINGS OF THE BOARD.

The public winter meeting of the Board for lectures and discussions was held at Amherst, Dec. 6, 7 and 8, 1898. The attendance was large, the average attendance of the six day sessions being nearly 250 by actual count, and the interest in the lectures and discussions was marked. It was one of the most successful meetings in the history of the Board. The lectures and discussions will be found printed on pages 13-217 of this volume. A special business meeting of the Board was held at Amherst, Dec. 8, 1898, an account of which will be found printed on pages 7-10. The annual business meeting of the Board was held at the office of the secretary, Jan. 10 and 11, 1899, and the minutes thereof, etc., will be found printed on pages 224-275 of this volume.

CHANGES IN THE BOARD.

There have been fewer changes in the membership of the Board than is usual, most of the members whose terms expired having been re-elected. Mr. F. H. Smith of Ashfield retired after three years, Samuel M. Raymond of Hinsdale after five years, E. A. Harwood of North Brookfield after seven years, and Nathan W. Shaw of North Raynham after ten years, service on the Board, the places of these gentlemen having been filled by the election of Henry A. Howard of Colrain, Alvan Barrus of Goshen, Chas. A. Gleason of New Braintree and Edward M. Thurston of Swansea.*

CATTLE COMMISSION.

The report of the Board of Cattle Commissioners (Pub. Doc. No. 51) is by law printed in the annual report of the State Board of Agriculture, and the report for 1898 will be found printed on pages 485-550 of this volume.

* Mr. Sprague S. Stetson of Lakeville, one of the Governor's appointees on the Board, died on January 12, the day following the annual meeting. The Governor appointed the member from the Essex Agricultural Society, Gen. Francis H. Appleton, to fill the vacancy. Mr. John M. Danforth of Lynnfield was elected by the Essex Society to fill out the unexpired term of Mr. Appleton.

FARMERS' NATIONAL CONGRESS.

The report of the delegates to the Farmers' National Congress at Fort Worth, Tex., Dec. 6-11, 1898, is by request included in this volume, and will be found printed on pages 553-563.

The last Legislature provided funds for the necessary expenses of a meeting of the Farmers' National Congress, if the Congress should decide to hold its 1899 meeting in Boston, and provided that the funds should be expended under the direction of the State Board of Agriculture. The Congress has accepted the invitation of citizens of Massachusetts, and has decided to hold its next session in Boston. The committee of arrangements has petitioned for the use of Faneuil Hall for the meetings. The Massachusetts Horticultural Society has also tendered to the Congress the use of its hall on Tremont Street. The Board of Agriculture will doubtless arrange to co-operate with that society and other local organizations in measures to make the Congress a pleasurable success.

CONCLUSION.

The reports of the gypsy moth committee and Dairy Bureau, which are by law required to be made to the Legislature, cover the most important work of the Board of Agriculture; and, as the secretary of the Board is by law made the executive officer of the Bureau and an important member of the gypsy moth committee, these two reports, printed elsewhere in this volume, show in detail much of the work of the secretary. These comparatively new departments of work take a large part of the time and energy of the secretary.

In closing this, my twelfth and last annual report, I desire to place on record the opinion that the Massachusetts State Board of Agriculture is an able, disinterested Board, and that the weighty interests committed to its care have always been carefully and conscientiously looked after. With the exception of the three members of the Dairy Bureau, the members of the Board receive no compensation for the time spent and work performed. The committee on Agricultural

College, acting for the Board as overseers of the college, have spent much time and have carefully performed the duties expected of them. The five members of the gypsy moth committee have each spent from thirty to sixty days time annually for several years, and have directed and been responsible for the expenditure of nearly \$1,000,000 appropriated by the State of Massachusetts. I doubt if another example of such disinterested and able administration of public duty can be found in the records of this or any other State. The other committees have been called upon to give more or less time to their duties, and each member spends several days each year in an inspection of the fairs held by the several agricultural societies. The Board is large in number, but, as it is representative in character and thoroughly organized for work, its numbers are no bar to its efficiency.

WM. R. SESSIONS,

Secretary of the State Board of Agriculture.

Boston, January, 1899.

MEETINGS OF THE EXECUTIVE COMMITTEE

OF THE

BOARD OF AGRICULTURE,

1898.

MEETINGS OF THE EXECUTIVE COMMITTEE,

ACTING FOR THE BOARD.

Boston, Feb. 9, 1898.

The committee this day by letter appointed Mr. D. A. Horton of Northampton chairman of the committee on Dairy Bureau and agricultural products, to fill the vacancy existing in the said committee; he thus by a by-law of the Board became a member of the executive committee.

The committee, having considered the matter of excusing certain societies for failure to make their returns to the Board within the time required by law, the causes of delay appearing reasonable, excused the societies and directed the secretary to notify them of the fact, with the understanding that the laws and the regulations of the Board will be complied with in future.

Boston, May 14, 1898.

A communication having been received from Mr. E. A. Harwood of North Brookfield, resigning the chairmanship of the committee on Agricultural College and education, the executive committee, having been consulted by letter, accepted the resignation and appointed Mr. John Bursley of West Barnstable, the second member of the above-named committee, to fill the vacant chairmanship. Mr. Bursley thus by a by-law of the Board became a member of the executive committee.

Boston, Dec. 23, 1898.

The meeting was called to consider the request of the Berkshire Agricultural Society for the approval by the Board of Agriculture of the vote of the said society, passed at the annual meeting of the society on Dec. 1, 1898, "that the president and treasurer be and are hereby authorized and empowered to borrow the sum of one thousand five hundred dollars, or such lesser sum as may seem to them

necessary, to be used in meeting the indebtedness of the society, to give to secure the payment of said sum a deed of mortgage of the real estate of the society subject to the mortgage now existing on said real estate."

There was presented the statement of the secretary of the society, giving a copy of the vote above quoted, a copy of the call for the meeting, showing that the meeting was called for the purpose of voting on this matter and that the meeting was properly warned, that the affirmative vote was unanimous and that there was a quorum present, which statement and copy of the vote was attested by said secretary. There was also presented copies of the "Berkshire Eagle," containing the advertisement call of the annual meeting and of the notice of the hearing.

No person appearing in opposition, it was

Voted, To approve for the Board of Agriculture the above-quoted vote of the Berkshire Agricultural Society, in accordance with the provisions of chapter 274 of the Acts of 1890.

SPECIAL MEETING
OF THE
BOARD OF AGRICULTURE,
AT
AMHERST.

DECEMBER 8, 1898.

SPECIAL MEETING OF THE BOARD OF AGRICULTURE, AT AMHERST.

AMHERST, MASS., Dec. 8, 1898.

The Board of Agriculture met in the town hall, Amherst, this day, at 9 A.M., for business.

Present: First Vice-President James S. Grinnell, who presided, and Messrs. Allen, J. S. Appleton, Jr., Baker, Barton, Benedict, Brewster, Bursley, Damon, Goessmann, Goodell, Hersey, Horton, Kilbourn, Lloyd, Pratt, Reed, Sargent, Sessions, Shaw, F. H. Smith, G. P. Smith, Stetson, Stockwell, Thayer and E. W. Wood.

The secretary presented the report of the gypsy moth committee to the Legislature, and explained the position and powers of the committee. He said:—

Perhaps I ought to say in explanation that the law under which the gypsy moth work is carried on provides that it shall be done by the secretary and a committee of the Board of Agriculture appointed by the Board, and it provides that the committee shall make report to the Legislature. This being the case, it seems only courteous and reasonable that before we report to the Legislature we should report to this Board, and receive its endorsement, if considered worthy of it. You are very well aware that this report with this endorsement will carry more weight with the Legislature than a report simply of the committee. We therefore present our report, and ask your endorsement if you consider it worthy.

We cannot give you the report of the expenditures, as they will not be complete until the last day of December. That is a matter of routine. We can say now that we shall spend the \$200,000, but the items of the expenditures we cannot give you until the first of January.

The report was read by the secretary and was then discussed at length by members of the Board and Professor Fernald.

On motion of Mr. J. W. Stockwell, it was unanimously *Voted*, To accept and adopt the report.

On motion of Mr. Stockwell, seconded by Mr. Hersey, it was

Voted, That the thanks of the Board be extended to the members of the gypsy moth committee and to Entomologist Fernald and Director Forbush for the efficient manner in which they have conducted the work in their charge.

Mr. CHARLES E. PARKER (of Holden). I am not a member of the Board, and perhaps I am meddling with what is not my business. I want to say that the committee on agriculture of the Legislature of which I was a member last winter, while they were anxious to do all that the State should do in exterminating this pest, felt strongly that there was another feature in this matter, — that Congress, after sending an entomologist, Professor Howard, to study into this matter, after he had reported in the language quoted to you by the secretary, — that it was the duty of Congress to come to the aid of this State. It strikes me that the gentlemen of this Board should take hold of this matter. I do not believe the appropriation bill would have gone through our Legislature last year if it had waited until later. I question whether the Legislature will willingly grant an appropriation, except the government takes hold and does its part. It has been said that we are not only working for Massachusetts, but for the United States; then why should Massachusetts pay all the expense? It seems to me that the gentlemen of the Board of Agriculture are the ones to take hold of this matter, and take whatever steps are necessary to get the help of the general government, — to get it to appropriate \$100,000, while Massachusetts puts in another \$100,000. The Legislature could not refuse that modest request. It seems to me you should do this before our Legislature sits. I bring these thoughts to you because they are my strong convictions, and I believe now is the time to act.

Mr. E. W. Wood (chairman gypsy moth committee). I

am glad that Mr. Parker has referred to this matter. I believe the general government should aid in this matter, and I believe the time has come when they should be asked to do it. As was stated in this report, entomologists from all the States of New England, I think, and from several other States, have visited this work either during the past year or previously, and they have unanimously approved of it. They have said, at the same time, "You are not doing this for Massachusetts alone, but for the whole country;" and I believe, if the matter was brought before Congress, we should have not only the aid of these men but they would reach their Congressmen in the different States. A resolve of this kind was passed three and four years ago, petitioning Congress, and at the same time during one of those Legislatures a law was passed forbidding this committee to do anything or expend any money outside of the limits of this State. That barred the committee from making any efforts along this line. But one of these years the matter was brought to the attention of Representative Cogswell of Salem. He was invited to meet with the committee. He said his sympathies were entirely with the work, and he had no doubt that, if it could be properly brought before Congress, every man of the Massachusetts delegation would do what he could in favor of it. Mr. Sessions, Mr. Appleton and Mr. Forbush, through some provision made by the governor from his private funds, went to Washington. Representative Cogswell made the statement that the proper way to bring the matter before Congress was to get the sanction of the secretary of agriculture. Secretary Morton said there had been various other petitions somewhat similar in character, but he was very careful not to commit himself. At the same time he was president of the United States Forestry Association, and was very much interested in the growing of forests. Mr. Sessions carried down photographs of the way the trees in the infested territory had been stripped; and when they showed these, Secretary Morton became more interested, and he said, frankly, "Gentlemen, you have a very strong case to present to the government," and intimated that, while he could not consistently recommend it, he would not oppose it. Senator

Lodge brought the matter before the Senate in the form of an amendment to an appropriation bill, and they passed it, granting \$40,000. The bill was taken with other bills before a conference committee, and this appropriation was thrown out. That was the end of that effort.

I believe, if this could be properly taken up and properly presented to Congress, there would be no difficulty in getting an appropriation.

Secretary SESSIONS. It seems to me that the only way to reach Congress is through the governor. In reference to one of these resolves that was passed several years ago, I took occasion to go to the governor and ask him what was going to be done. He read it over, and I asked him if it was not some one's business to send it to Congress. He said, "The resolve does not provide that any one shall do it, and what nobody else does the governor must do." I believe if the matter was brought before the governor he would see to it.

On motion of Mr. W. B. Barton, it was

Voted, That the secretary be instructed to call the attention of the governor to the resolutions of the last Legislature, memorializing the Congress of the United States to grant an appropriation to assist the Commonwealth in the work of extermination of the gypsy moth, and in the name of the Board of Agriculture to ask His Excellency to take measures to bring the memorial to the knowledge of Congress by sending a copy to our Senators and Representatives, or otherwise, as he may think proper.

Adjourned.

PUBLIC WINTER MEETING
OF THE
BOARD OF AGRICULTURE,
AT
AMHERST.

DECEMBER 6, 7 AND 8, 1898.

PUBLIC WINTER MEETING OF THE BOARD,
AT AMHERST.

The annual public winter meeting of the Board was held in the town hall, Amherst, on Tuesday, Wednesday and Thursday, December 6, 7 and 8. The weather was favorable, and the attendance was the largest in the later history of these meetings. The lectures were interesting and the meeting was a success.

The first session was called to order by Secretary Sessions, who introduced First Vice-President James S. Grinnell as presiding officer.

Mr. GRINNELL. You will please give your attention while the Rev. Dr. Walker, chaplain of the Massachusetts Agricultural College, invokes divine blessing on our labors.

Prayer by Dr. Walker.

Mr. GRINNELL. It is my pleasure next to call upon, not to introduce, one who presides over our college, our beloved president, who will give the opening address.

President GOODELL. I did not know that the few remarks that I was expected to make by way of welcoming you would be dignified by the name of opening address, and I hope you will dismiss that from your minds at once. When the secretary of this Board announced to me that I had been chosen to make a few welcoming remarks, he informed me that I was chosen for the reason that they knew I would be short, — that they wanted a short man and a brief man.

I have a way sometimes of worrying a subject, and if you see a tendency in me to do that this morning, please check me at once.

I want to commence with the words of Colonel Clark to this Board when they met here thirty years ago. He said "Gentlemen, you do not know how glad I am to see you here." Now, adding to the reasons why he was glad to see the Board here, I have still another reason. You know it

is customary to date all events from some striking occurrence that may have happened, and chronology has arisen in that way. When Mahomet fled away into exile, the Hegirah or date of his departure became the point from which the chronology of his followers began. The Greeks based their chronology upon the Grecian games, and everything was dated either before or subsequent to that. In the winter when the Board met here thirty years ago it was some time in the month of December, and it was terribly cold. I drove a sort of barge between here and the college. I had recently come to this country, and in my guileless, trustful simplicity, I trusted myself to the rigors of that weather without proper covering, and froze my ear. Since then I have dated all events from the day of freezing. The good book tells us that if the enemy smite you on one cheek to turn the other also, and for the sake of having this Board come here again, I am willing to turn my other ear and have it frozen, if so be I can get you here.

It was a wonderful array of men that were present thirty years ago. Too many of them, alas, have passed beyond our ken and can no longer instruct us. The handsome governor of Massachusetts, Dr. Loring, Professor Agassiz, Alexander Hyde, Marshall P. Wilder, Captain Moore, Velorous Taft, Colonel Stone, Mr. Bull of Concord, Dr. Durfee of Fall River, Mr. Goodman of Berkshire, — all of whom have now gone beyond the river. I think all of them took part either in the way of essay, lecture or discussion. A very interesting thing happened at that time. The question of covering our hillsides with fruit trees and orchards came up, and Professor Agassiz advanced the hope that he might live to see the day when all our hillsides should be covered with vines, and there should flow from them wine, good, pure and cheap for the people. Velorous Taft locked horns with him at once on the subject of temperance, and if it had not been for Colonel Clark jumping up and pouring oil on the troubled waters, I do not know how long the discussion would have continued.

Professor Agassiz, who was one of our staunchest friends, afterwards arose and said that when this question of agricultural colleges had arisen, he was opposed to having one

in Massachusetts; and Velorous Taft got up and said that this being an occasion of confidence he would say that he too had been opposed to it, but that he had come and seen, and was converted.

I note in looking over the addresses delivered at that time that there was the same trouble thirty years ago that there is at the present time. Mr. Clift delivered an address on "How to make farming profitable." He said: "You farmers must bring your farms into a condition to produce two and one-half tons of hay per acre, and if you can bring your land beyond that, put in more land. What you want is [he repeated it three times] manure, manure, manure; and with all your gettings, get manure." Professor Agassiz on that occasion spoke on "The origin of agricultural soils." X. A. Willard spoke on "Dairy products," and he, too, has gone beyond the river. Alexander Hyde spoke on "The hay crop." He made the statement that by the census of 1865 the hay product was something like thirteen millions, while the products of the corn and all other crops amounted to not exceeding four millions. Professor Stockbridge, the Nestor of Agriculture and the only one remaining of those who were here at that time, spoke on the "Art of agriculture," but ever since that time he has been speaking not on the art but on the practice of agriculture. Colonel Clark, in making an address on the college, spoke of what he wanted, and he wanted everything under the sun. When I tell you what the college had, you can readily understand why he wanted so much. There were four buildings only, no green-house, no equipment whatsoever. There were four professors, and no library, no apparatus. Now I think if these good men who were here at that time and who so heartily subscribed to what Colonel Clark said, and agreed to use their influence with the Legislature,—I think they would be impressed if they could come back now and see that instead of four buildings we have twenty-eight; a library of over nineteen thousand volumes, containing all the latest scientific works,—a first-class working library; instead of four professors, we have a teaching force of eighteen; instead of no equipment and no apparatus, we have some of the finest in the land.

I could go on with these reminiscences of what occurred at that time, but I am here simply to welcome you, and I desire to welcome you here in behalf of the town of Amherst, crowned with its two institutions of education; I desire to welcome you in behalf of Amherst College, with its seventy-seven years of usefulness; I desire to welcome you in behalf of your college, the Massachusetts Agricultural College, founded under your auspices, nurtured by your care, watched over by you, a college with its thirty-one years of usefulness.

MR. GRINNELL. It has been decided that Mr. A. M. Lyman, president of the Hampshire Society, should preside over the meeting at this session. I beg to introduce to you Mr. Lyman, president of the Hampshire Agricultural Society.

MR. A. M. LYMAN. I am very much pleased with the spirit of intense earnestness in the science of agriculture, manifested by the presence of so many people. It denotes the interest which is common among the most of us. It is very encouraging to know that there are so many young people in our vicinity, and far around, that are taking up agriculture for all there is in it. The fascination of the possibilities is a great incentive. That which we get in a practical way on the farm is combined with what we may get from the Agricultural College in the way of printed bulletins which are free to all, showing the scientific principles brought to a practical test, ready to be applied to our every-day needs and benefits.

We are told that what characterizes American men of science is their intensely practical spirit. The best examples of the utilization of the advances of science are found in the work of certain government departments. The saving to the farming interests of the country through the bureau of entomology pays the expenses of that office many times over. In the geological survey there is gathered and published information of the greatest value concerning the mineral resources of the United States. By the systematic study of hydrography it has been possible by skilful irrigation to convert extensive desert tracts in the mountain basins of Arizona and New Mexico into veritable garden

spots. Within the last quarter of a century, through the labors of Hazen, Greeley, Harrington and Moore, the weather service has become the equal of any on the continent of Europe, while there is none which gathers its data from an area of such extent and variety of features.

There is great encouragement for the farmers. We should co-operate with our Agricultural College.

I extend to you a welcome in behalf of the Hampshire Agricultural Society. In making up the programme for this morning the committee wished to have a very interesting subject and to get a very interesting speaker, and they have done so in securing one who has long been connected with the work in many lines and directions, and especially in the line of the subject this morning, which is "What the experiment stations have learned about raising and curing tobacco." We have with us Dr. E. H. Jenkins, vice-director of the Connecticut Agricultural Experiment Station, who will speak to us on this subject.

Dr. JENKINS. Ladies and Gentlemen: I wish to express a word of acknowledgment of the kind words of the presiding officer. I am reminded of something that was said at the last meeting of our Board of Agriculture. Professor Bailey was speaking on agriculture. After he had finished, a gentleman arose and said that was all very well, but he wanted to hear him talk about horticulture; he said: "Here is a man from New York who knows more about horticulture than any man in this State. I doubt if there is a man in the world who knows as much about horticulture as Professor Bailey." When Professor Bailey responded he said he now knew how the "flapjack" felt when it was covered with molasses.

WHAT THE EXPERIMENT STATIONS HAVE LEARNED ABOUT RAISING AND CURING TOBACCO.

BY DR. E. H. JENKINS, NEW HAVEN, CONN.

It would be hard to say just what the stations — entirely apart from experienced tobacco growers — had learned about raising and curing the weed. It would be quite as hard to say what experienced tobacco growers, without any hint or help from the station, had learned about these same things within the last ten years. And the reason why it is difficult to say just what each has separately done is, because our stations and our growers have all the while worked together. In Connecticut, at least, no other class of farmers calls on the station so constantly for its help as the tobacco growers. This is as it should be. The tobacco grower meets very strong competition, and knows that the only safe way to meet it is by superior quality of leaf. And he knows that in some ways the chemist, the botanist and the experimenter can help him. The station man certainly knows that he cannot experiment on growing tobacco without the constant help of an experienced practical grower. We all are, or should be, workers together for the same end.

But what we want now are the facts about tobacco, no matter who first got hold of them. “Spot” knowledge is what we are after.

Of course, we are now talking *wholly* of wrapper leaf, such as is raised almost exclusively in Massachusetts and Connecticut.

In the first place, then, we have learned that the fineness or texture of the soil largely fixes the color, and, to some degree, the texture of the leaf. That is, light cinnamon-brown leaf, as a rule, can only be raised on sandy, light lands, which are nearly free from loam or clay. No known

variety of seed, no special fertilizer or method of growing will give a light-colored leaf on a loam or clay soil.

On the other hand, very dark colors cannot be produced on light, sandy land, except, perhaps, by using animal fertilizers, rich in nitrogen, and in quantity large enough to spoil the texture, burn or taste of the leaf.

Our best tobacco soils are too light for staple farm crops, but heavily manured, make excellent garden-truck farms for quick-growing spring vegetables. They rarely have over five per cent of clay in them.

On the other hand, the main crop of Pennsylvania tobacco is grown on limestone soil, which may contain thirty per cent or more of clay. Hence the Pennsylvania wrapper is, *on the average*, much darker than the Connecticut valley wrapper. But if the fashion changes, so that dark wrappers become popular again, our lightest tobacco lands must be abandoned and the heavier "meadow" land taken up.

The following table, taken from Professor Whitney's Bulletin No. 11, on the tobacco soils of the United States, page 18, gives averages of mechanical analyses of various types of soils on which wrappers, fillers and binders are grown:—

Average Mechanical Analyses of Various Kinds of Tobacco Soils.

No. of Samples.	District.	Principal Grade of Leaf produced at the Present Time.	Moisture in Air — Dry Sample.	Organic Matter.	Gravel (2-1 mm.).	Coarse Sand (1-0.5 mm.).	Medium Sand (0.5-0.25 mm.).	Fine Sand (0.25-0.1 mm.).	Very Fine Sand (0.1-0.05 mm.).	Silt (0.05-0.01 mm.).	Fine Silt (0.01-0.005 mm.).	Clay (0.005-0.0001 mm.).
9	Connecticut,	Wrapper and binder,	Per Cent. 0.76	Per Cent. 2.53	Per Cent. 1.03	Per Cent. 3.26	Per Cent. 9.92	Per Cent. 22.62	Per Cent. 45.47	Per Cent. 10.41	Per Cent. 1.36	Per Cent. 2.32
5	Massachusetts,	Wrapper and binder,	.61	2.20	—	.04	.71	10.09	49.26	30.89	2.71	3.31
10	New York,	Wrapper and binder,	1.06	2.82	1.94	2.80	9.02	24.47	32.52	15.09	3.09	7.43
5	Pennsylvania,*	Wrapper and binder,	2.03	3.23	.67	1.23	5.87	6.62	37.18	23.41	5.21	13.80
10	Wisconsin,	Binder,	4.70	2.93	.59	1.09	4.98	10.34	15.68	31.04	6.01	22.76
4	Ohio,	Filler,	3.05	2.67	.39	.76	2.25	5.04	15.36	37.60	6.41	27.52
6	Pennsylvania,†	Filler,	3.61	4.47	.68	.78	.91	2.47	13.89	34.23	9.79	29.27

* River land and shaly limestone.

† Trenton limestone.

Our Connecticut and Massachusetts “meadow lands,” to which I referred as producing a darker leaf, are not really clay soils, but contain a large amount of fine silt, the next thing to clay, and are retentive of moisture.

A soil expert, by determining the fineness of the soil in his laboratory, can say positively whether a soil will grow a light-colored leaf or not, just as the experienced grower may judge of the same thing pretty accurately by the *feeling* of the soil.

The important thing for the practical farmer is to remember that his success in tobacco growing—as in any other kind of farming—is settled for him by the kind of soil he selects for the crop. He can't gather figs off thistles, nor kick against the pricks. On loams he may raise a good mahogany-colored wrapper, on clayey soil he may raise fine filler tobacco, but on neither can he raise the lightest-colored, fine-textured wrapper leaf.

Again, connected with this matter of soil texture is the water content of tobacco soils. It is quite possible that the water supply is the thing which regulates this matter of color and texture of leaf, the water supply being in turn regulated largely by the soil texture. Our best tobacco soils seldom contain more than 7 or 8 per cent of moisture, to a depth of 8 inches, during the summer. I have seen it drop to nearly 6 per cent for a time, without hurting the crop. But the “meadow lands,” which yield heavier, darker tobacco, contain from 20 to 28 per cent. The best Pennsylvania soils carry 18 per cent, and the limestone clay soils, suitable only for growing filler leaf, have from 22 to 23 per cent of moisture.

Note this low percentage of moisture in our best tobacco soils,—only 7 per cent. It is strange that such a large, leafy plant as tobacco can do well in a soil too dry for potatoes, sometimes too dry for corn.

But it is clear that tobacco has only a small “margin of safety” as regards moisture. Only a slight drop in the water content of the soil will damage or ruin the crop. A drought which does not seriously hurt corn will injure tobacco. The crop depends on frequent rains, evenly distributed through the season, and on skilful cultivation to

keep the soil water from evaporating through the soil, instead of through the crop. If the crop, at any time after it is half grown, is pinched for two weeks in its water supply, it is sure to be of inferior quality. Considering this small supply of water which our best tobacco lands have and the great inequality in our summer rains, as well as the great damage done by a short season of drought, a chance to irrigate tobacco fields is a great help.

One of our best growers in Connecticut has a dam, making a pond, from which he can irrigate the crop when necessary, and he does this about two years out of every three. The water is run through between the rows, *rapidly*, till it reaches the further end of the field, and is then shut off and turned into other rows. He has saved some crops from total failure, and oftener has protected them from serious damage.

This last season our experiment tobacco, on a little drier land, to be sure, was damaged by a dry spell, while his tobacco, with a single irrigation, kept right on and made a perfect crop.

Much is done, however, to protect tobacco in a dry time, by *judicious* and *constant cultivation*; much harm is done, too, by cultivation of another kind. I find men who say that you supply the plants with moisture by throwing up the damp earth against the stalks and the mass of roots near them, in a dry time. This is nonsense. If you want to dry out your land near the surface, cultivate it deeply, the deeper the better. If you want to keep the moisture in it in a dry time, cultivate it just as shallow as you can. Break the surface crust; that is all. Don't bring any damp earth to the surface if you can help it. All the earth which you stir is the drier for it, but what you do not stir will not lose its water as quickly for the stirring. After rains, deeper cultivation will do no harm, it may help to aerate the soil; but in a drought go over the surface as lightly as you can. If you could cover the ground with empty fertilizer bags, they would hold the moisture as well as could be. Instead of that, make a layer of light, fluffy earth with your cultivator, but not much thicker than a fertilizer bag.

So much for soil texture and soil moisture.

Next, What have we learned of the food of the crop? What does it take out of the soil?

Of course the larger part of the weight of the plant, either in the field or after curing, has been taken out of the air. All the solid matter of the woody tissue, the starch, sugar, gum, fat, wax, green coloring matter and the larger part of the nicotine and protein, too, come, not from the mineral matters of the soil or the fertilizers, but from the air, and, we believe, are always there in sufficient quantity to meet all the demands of any crop. Mineral matters and nitrogen make up only 25 or 30 per cent even of the air-dry cured leaves, and, of course, in the green plant the proportion is very much smaller. But these mineral elements are as essential to life and growth as those other things which make up most of the weight of the crop.

A tobacco plant can no more live without potash, for instance, than without sunlight or water.

What, then, are these mineral elements, and how much of them does an average crop take out of the soil.

At our usual distance of planting (rows 3 1-2 feet apart, 18 inches in the row) we get something more than 8,000 plants on an acre. A good crop is 1,875 pounds of pole-cured leaves. The stalks, at stripping time, will weigh about 3,200 pounds.

If the soil has been for years well dressed with fertilizers, we may figure on the following quantities of nitrogen and mineral matters in this crop:—

Quantities of Nitrogen and Mineral Matters in a Crop of Tobacco.

	In 1,800 Pounds of Leaf (Pounds).	In 3,200 Pounds of Stalks (Pounds).	Total (Pounds).
Nitrogen, ...	65	32	97
Phosphoric acid, ...	8	8	16
Potash, ...	89	49	138
Soda, ...	4	3	7
Lime, ...	81	13	94
Magnesia, ...	25	5	30
Sulphuric acid, ...	16	5	21
Chlorine, ...	5	6	11

In round numbers, we may say that a good crop, on well-fertilized land, may take from it 100 pounds each of nitrogen and of lime, 140 pounds of potash, scarcely any soda or chlorine and less than 20 pounds of phosphoric acid; of sulphuric acid and magnesia, 20 and 30 pounds respectively.

These facts are instructive, and give us a valuable guide in the use of fertilizers; but let us not misinterpret them.

In the first place, they do not show that a crop of 1,800 pounds of leaf tobacco must contain 140 pounds of potash or 100 of nitrogen. A crop of 1,800 pounds of tobacco of excellent quality *may* contain considerably less than these amounts, and yet be of first-rate quality. A tobacco crop will not take up just what it needs from the soil, and leave the rest. Within certain limits, it will take up what it finds, and often in excess of its wants.

Thus, in our Poquonock experiments, where fertilizer-nitrogen was put on in large excess of the probable crop requirements, a much larger quantity of nitrates and somewhat more protein and nicotine were found in the leaf than where less fertilizer-nitrogen was used.

The largest percentage of potash was found in the tobacco to which most fertilizer potash was applied.

The same general fact was also true of magnesia and of sulphuric acid, viz., the larger the supply in the soil, the more went into the tobacco, and this excess did not, in any way apparent, affect the quality of the crop.

Hence these figures do *not* show the quantity of plant food which a tobacco crop must have. They show that, *plus* the excess which the abundantly fed plant will take up.

To illustrate: your butchers' and grocers' bills, with what food you take from the farm, show what your family has eaten for the year. This table shows somewhat the same regarding the tobacco crop.

But you know that your housekeeping account does not show what the members of your family needed to keep them alive and well. They could have got on with less food, with fewer appetizing things, which may be called luxuries, and have been just as well for it at the year's end. The same is true of the tobacco crop. Doubtless, with less potash, less

nitrogen or less lime than what I have named, the crop can make as much growth and as good a quality of leaf.

In the second place, these quantities of plant food named in the table are not derived wholly from the fertilizers put on to the land just before planting. They came, in part, from the decayed stubble of last year, the fertilizer residues left over and not taken up by the previous crop, and from plant food which has weathered out from the grains of the soil itself. The food of your family includes not only what is in the butchers' and grocers' bills, but also what has come from the farm itself, of which it is hard to keep an account or even an estimate. So this plant food of the tobacco crop is not wholly what is shown in your fertilizer bills, but has in part come from the farm, *i. e.*, from the substance of the soil itself. And, just as you cannot well determine what part of your own food is taken from off your farm, so it is impossible to tell what part of the plant food of a crop comes from the soil.

However, bearing all this in mind, we may say that a tobacco crop takes about so much plant food from the soil, just as we say it takes about so much food, or it costs us about so much for food, a year.

This brings us to inquire what have we learned about fertilizers for tobacco?

First, how much of this plant food must we supply in fertilizers? What part can we leave to the soil to supply? This is one of the many questions which we are always asking, but can never answer definitely and certainly.

Our best tobacco soils are coarse in structure and not naturally fertile. They are soils, too, which we should least expect to hold the plant food put on them and keep it from leaching when not bearing crops.

And, once more, it is usual to let tobacco land lie fallow for nearly nine months of the year, nothing growing on it but suckers and perhaps weeds, and all conditions right for leaching out its soluble plant food, at least the nitrogen and lime.

For no other crop do we leave the land so long bare of any vegetation which can gather up and hold the plant food which is adrift in the soil and thus prevent its loss. Con-

sidering these things, and that it will not do to take any risk on quality of leaf by economizing in fertilizers, I believe it is wise, on land not known to have been very liberally dressed for years, to put on annually at *least* 125 pounds of nitrogen and 150 to 200 pounds of potash, the larger quantity I should prefer, and not mind either the phosphoric acid or lime, because, with the nitrogen and potash, these will be incidentally supplied. This, you see, reckons but little on the soil supply of either nitrogen or phosphoric acid.

On new land I would advise even more nitrogen. You are not likely to injure the quality of leaf by over doses of nitrogen, at least in such forms as cotton seed or castor pomace.

At Poquonock, for five years in succession, — always in connection with 1,100 pounds of cotton-hull ashes, — we put on 2,900 of cotton-seed meal, or 4,400 of castor pomace, each representing 210 pounds of nitrogen per acre, on two plots, and got more tobacco and better quality of leaf for the five years from these than from two other plots which had half as much, or two others which had two-thirds as much nitrogen. That land was new to tobacco when we began. On lands longer cultivated and heavily dressed I should cut down to say 130 pounds of potash, in case little manure is used, and put on not more than 100 to 130 pounds of nitrogen.

Here, you see, I am drifting away from what we *know* about the crop to the experience of the grower.

As to lime, on new land there is likely to be enough for the crop already in the soil, but after land has been in tobacco for years it is not so certain. We have learned that the potash and ammonia of manures are held or fixed by the soil; they are not easily leached out of it; but we must not forget that, with this fixation, there goes at equal pace an unfixing, a freeing of other bases in the soil, particularly of lime and magnesia, which pass into the soil water and so may leach out; so that the continuous use of potash salts tends to exhaust lime from the soil.

Hence, on old tobacco soils an occasional liming is worth while, best in the fall, perhaps, with 500 pounds to the acre, unless wood ashes which contain over 30 per cent of

lime, chiefly in form of carbonate, have been abundantly used.

So much regarding the amount of plant food to be used per acre.

Now, what have we learned about the special forms of plant food best suited to the crop?

One thing at the outset. We have talked so much about the effect of forms of plant food on quality of leaf that we have sometimes forgotten this, that plant food is only one factor in the yield and quality of the crop. Nitrogen, phosphoric acid and potash are not all there is to tobacco growing.

The season and the rain supply greatly affect the quality of the leaf, and, with the best forms and quantities of plant food, tobacco may yet have poor burn and generally undesirable texture, color and size.

The crop is a product of all the other factors of growth, as well as of the food of the plant. Many of these factors are quite beyond control.

First, about green manuring. It is common to let tobacco land lie, as I have said, from eight to nine months every year with nothing on it. I believe this is wasteful, and within a few years some of our best growers are sowing rye in the fall, to turn under in the spring.

The aim is, first, to hold the soil in place, — for some of our best tobacco land actually drifts in high winds; and, secondly and chiefly, to gather the soluble plant food of the soil, particularly nitrogen, and hold it so that it will not leach out in the heavy rains of the fall, winter and spring.

Rye, like other grasses, makes a great root growth before it does much above ground, and it is at work all winter, wherever the ground is not frozen, *i. e.*, wherever plant food is adrift. The practice is certainly a very good one, but mind these two things: sow it rather late, so that it will not make too large a growth, and plough it under in the spring, before it heads out. If you do not, it pumps too much water out of the soil and gets so woody that it will not rot down quickly, but leaves the soil in which it lies light and fluffy, with little moisture.

Some allege that this green manuring may favor cut-worms in the soil. Such has not been our experience. Last year the only piece which was fairly clear of cut-worms was one which had rye on it through the previous winter.

But what about forms of plant food for tobacco?

I hardly need to say that chlorides or muriates are everywhere regarded as hurtful. Muriates often increase the yield, but at the expense of quality. A certain very small amount of chlorine, not more than 5 pounds to the acre, is necessary to the plant, and it certainly can stand more. The ash of wrapper leaves grown with fertilizer chemicals contained only about .5 per cent of chlorine in our experiments, but where stable manure had been used for five years there was over 10 per cent of chlorine, yet the tobacco raised on this manure was of good quality. Certainly where stable manure is used there will be more chlorine in the crop than where only chemicals are applied.

Our own experience at Poquonock has made us somewhat distrust sulphates. The tobacco from a plot to which sulphate of ammonia had been yearly applied was for a term of five years of poor quality, and that from the plot dressed with high-grade sulphate of potash for five years was also comparatively poor. Others, I know, have had excellent results with high-grade sulphate. Your own station got good results with it, but ranked it a little below cotton-hull ashes or carbonate of potash.

I think it is safe to say that considerable doses of acid phosphate, year after year, are likely to injure the quality of leaf.

For the rest, what I have to say is based on the results of five years' experiments on a typical light tobacco soil at Poquonock, set with Connecticut Havana tobacco. You probably know in general the plan of that work. The field and barn are owned by the Connecticut Tobacco Experiment Company, a corporation composed mainly of tobacco growers; and its objects are to study methods of raising, curing and fermenting New England tobacco. The crop is raised by an experienced tobacco grower. Each plot, of one-twentieth of an acre, was fertilized yearly in the same way for five years; each crop was kept separate in the

curing barn, and, after sorting, large samples of first and second wrappers from each plot were cased down and fermented by a tobacco dealer. The next fall each crop, labelled so as to distinguish it, without giving the expert an idea from which plot it came, was very carefully examined and tested by a dealer in leaf tobacco; its burn, ash, color, texture, yield, size, vein and stem were all noted; and, lastly, its grade or rank, as compared with the others. The best was marked 1st, the poorest 29th, and the intermediate ones in their order of value. During these five years, of course, we got wet seasons and dry, large yields and small, very good tobacco and very poor tobacco.

Of course, the comparative value of the crop from a given plot was not exactly the same in all years. For instance, one lot of leaf was graded 14th in one year, the next year 2d, the next 1st, the next 7th. If, now, we average these numbers, we get an expression of the relative average quality for the whole period of experiment.

The work was done jointly by this experiment company and the Connecticut station at New Haven, the station bearing most of the expense; it was done as carefully and with as much skill in the field and in the laboratory as was possible, so that any defects in it are inherent in the nature of the thing itself, and not in the way of doing it.

Now, what, in brief, is the showing of these experiments on the effect of different fertilizers on the quality and quantity of the crop?

A word as to yield. The average yield of all the plots, good and poor, was 1,685 pounds sorted leaf per acre, ranging from 1,568 in one year to 1,876 pounds in another. The largest yield from any one plot was at the rate of 2,280 pounds. On the average of five years, from all plots, good and bad, we got 60.7 per cent of wrappers, ranging from 47.2 to 66.6. On some plots we got as high as 78 per cent. This much is to show that, one season with another, we had about average success.

1. As to the effect of quantity of fertilizer nitrogen on the crop, 3,000 pounds of cotton-seed meal per acre (210 pounds nitrogen) gave a larger crop and a better quality of leaf for five years than either 1,500 (105 pounds nitrogen)

or 2,000 pounds (175 pounds nitrogen). The same thing was true of equivalent quantities of castor pomace.

2. We found no advantage in using nitrate of soda in connection with cotton-seed meal or castor pomace.

3. As to comparative value of cotton-seed meal and castor pomace, we got slightly larger yields from castor pomace, but not quite as good a quality. The difference in this respect was not large. We put on both fertilizers not long before setting time. Some advocates of pomace say it should be ploughed under lightly some time earlier, being rather slower to decay than cotton seed.

4. In four years' tests linseed meal gave a somewhat smaller yield than either cotton seed or pomace, but decidedly better quality.

5. Dry fish, in a four years' test, gave a much smaller yield than cotton-seed meal, by 250 pounds to the acre, and a smaller percentage of wrappers, so that its use was unprofitable; but yet the quality of the wrappers was excellent, — better even than that of those raised on cotton-seed meal.

6. Stable manure, at the rate of 10 to 12 cords per acre, was tested for four years, and also stems, at the rate of 6,000 pounds per acre, and for the last two years of experiment 500 pounds of Swift Sure superphosphate were used with each as a starter.

The results are not strictly comparable with those on plots where meal or pomace was used, because these last were cultivated for five years and the plots with manure and stems for only four years; 6,000 pounds of stems carry about 111 pounds of nitrogen, 36 of phosphoric acid and 486 pounds of potash.

The yield of tobacco from the plot which was dressed with stems was about the average of the other plots, and its quality about like that of tobacco from a plot which was dressed with 1,500 pounds of cotton-seed meal and 1,200 of cotton-hull ashes.

Ten to twelve cords of stable manure carried about 111 pounds of nitrogen, 71 of phosphoric acid and 149 pounds of potash. The yield of tobacco from this was scant, — about 250 pounds to the acre, less than the average of all

the plots; but its quality was among the best, ranking, for the four years, 6th among the twenty-nine.

This brings us to the question of stable manure *v.* commercial fertilizers for tobacco. Notice that average stable manure, with litter, may contain about 10 pounds of nitrogen to the cord, so that 10 or 12 cords per acre would contain enough nitrogen for a tobacco crop, if only it were *quickly available*, like that of cotton-seed meal or pomace. But it is not, generally speaking, nearly as available, — probably not more than half as available. Now, if manure is used at the rate of from 10 to 15 cords a year for a term of years, it is quite possible to get the land so well stocked with organic nitrogen that the amount becoming available yearly will cover the demand of the crop. I believe, however, it is safer to use a moderate quantity of cotton-seed meal or pomace just before planting, to help out the dressing of manure.

There is no question that tobacco grown on a dressing of manure, — not wet with sea water, as it sometimes is when brought up from New York in barges, — has a fine quality, which does not show at its best till it has been through the fermentation.

Most growers like to use what manure they have on their tobacco fields, and believe in it to that extent; but when it comes to the question of buying it in large amounts as the chief reliance, the views of growers are sharply divided. My own belief is that a heavy dressing of stable manure every few years, or, preferably, a lighter dressing yearly, will, by reason of the humus-forming matter in it, protect the crop from drought to some extent, and improve its quality; but that, unless used in very large quantity, it needs some fertilizer supplying quickly available nitrogen to piece it out, and perhaps some form of potash.

7. As to the comparative effects on the quality of leaf of various forms of potash: —

On each of 8 plots we used annually about 1,500 pounds of cotton-seed meal (105 pounds of nitrogen) per acre and 340 pounds of actual potash, *but in different forms*. These different forms were: cotton-hull ashes, wood ashes, carbonate of potash, double carbonate of potash and magnesia,

high-grade sulphate of potash, the same with lime, double sulphate of potash and magnesia, commonly called "low-grade" sulphate, and the same with lime.

The plots that had ashes were supplied with 150 pounds of phosphoric acid per acre, in the ashes themselves, so to the other plots we added this quantity of phosphoric acid in form of Cooper's bone dust, to make the conditions as nearly even as we could. Averaging the results of five years together, good seasons and bad, we find that the plots dressed with ashes and other forms of carbonate yielded less tobacco yearly by 100 to 150 pounds than those dressed with some form of sulphate of potash.

But in general quality of leaf the tobacco dressed with carbonates was considerably better than that dressed with sulphates. The tobacco raised on the double carbonate of potash and magnesia was the best we raised; that on wood ashes came next. It was noticed that, as a rule, the tobacco raised on the sulphates did not have as good a burn nor hold fire quite as long as that raised with the carbonates.

These experiments in the application of fertilizers to tobacco have been carried out for five years with all the care and skill at our command. Certain questions regarding the effects of a number of fertilizer materials, which have been vainly discussed for a long time, have been answered by these experiments as completely and definitely as is in the nature of things possible.

One fact, emphasized by our experience, is that there is no "best" tobacco fertilizer or "best" formula for all seasons, even on the same soil. A formula or a form of plant food which in one season gives to the leaf a somewhat better quality than any other, may, perhaps, the next year and on the same soil prove inferior to others, for reasons which can only be surmised. Nevertheless, by comparing the effects of these fertilizers for a term of years, it appears that certain ones are, on the whole and generally speaking, more likely to impart a perfectly satisfactory quality to the leaf than certain others.

The opinions of growers regarding tobacco fertilizers are widely divergent, and the prejudices of both growers and dealers are sometimes strong. Thus, certain growers de-

clare that they would not use stable manure on tobacco, if it cost them nothing to use it; others would use nothing else, if they could buy enough manure.

In 1897 the only tobacco which remained green through the growing season and ripened normally, while all other tobacco in the field turned yellow and was certainly injured by the excessive rainfall, was that grown on the plot which annually for five years had been dressed with 10 to 12 cords of stable manure per acre. (Plot AA, the yield of which was graded 13th, 1st, 17th and 3d in four successive years.)

Certain dealers refuse to buy crops from land on which linseed meal was used. The result of our four years' tests show no ground for this objection.

Some growers believe that castor pomace is greatly superior to cotton-seed meal as a fertilizer; others condemn pomace. Yet careful comparison for five years fails to show any great difference in their effects. The summary already given shows other illustrations of the fact that on this soil, typical of much of our tobacco land, careful experiments, managed by a skilful and successful grower, and with all facilities for accurate work, do not justify many of the opinions of growers and dealers regarding the effects of different forms of plant food on the quality of wrapper tobacco.

It is doubtless true of tobacco, as of other crops, that the liberal but not greatly excessive supply of readily available plant food yearly required to insure a paying crop may be given in a variety of forms, with equally good results on the average of one season with another, and that indeed occasional changes in the form of nitrogen and potash supplied may be a distinct advantage; avoiding always any considerable quantity of those things — chlorine and sulphuric or other free acids — which experience has shown may damage the leaf.

Before leaving the subject of fertilizers, a word might be said regarding the way to put them on. Shall we plough them in lightly, or harrow and cultivate them in? We have tried both ways, have been successful with both and have failed with both; and our experience is an epitome of that of all growers, I think.

When there is sufficient rain, well distributed in showers, during the first few weeks of growth, it makes little difference whether the fertilizers are near the surface or deeper. If very heavy rains follow planting, it is an advantage to have the fertilizer on the surface, because the plant roots have a better chance to get it. If the fertilizer is ploughed in and is below the plant roots, very heavy rains may carry it too far down for them to get it promptly.

But, on the other hand, if little rain falls in the first week after setting, the crop will do best if the fertilizers are well down, where the soil is moist; if near the surface they may burn the plants.

Hence we cannot say that one method is superior to the other. All depends upon the season, and when the land is prepared for setting the crop, no one knows what the eccentricities of the season will be.

This matter of fertilizers we could discuss all day and still be at odds over it when night came; but I must drop it now to say something regarding the curing of tobacco.

What happens while the leaf is curing in the barn? In the first place, it dries out. The tobacco from an acre of land does not, of course, always weigh the same, but even a moderate crop may weigh, as it is hauled in, 25,000 pounds per acre. A week later, it may weigh 16,000; in another week, 12,000; the next week, 10,000; and a month later, when it is ready to be stripped, 5,500 pounds, of which 1,550 pounds are leaves and 3,950 pounds are stalks. That is, during the cure, 19,500 pounds of water, $9\frac{3}{4}$ tons, have gone out through the doors and ventilators, and you take down at stripping time little more than one-fifth of the weight which you hung up at harvest. These figures are the results of weights made this year, — they are not a guess.

In the next place, the leaves first ripen and then die. Along with this ripening and dying certain chemical changes take place, caused in part, perhaps, by fermentation, but about this we know very little.

But, as a result of all this drying, ripening, dying and fermenting, the sticky, brittle, green leaf becomes a very thin, glossy, elastic, cinnamon-brown tissue, suitable, after fermenting in the case or bulk and seasoning, to wrap cigars.

We are all familiar with the look and behavior of tobacco during the barn or pole cure. The process, *under the most favorable conditions of weather*, when no long storms or protracted drought and hot weather interfere with its course, is about as follows : —

The plants first wilt completely, losing a very large part of the water which was in them, and hang down like wet rags, leaving air spaces between the lath through which you can see clear to the top of the barn, and through which there is a free circulation of air, — a thing which is essential to an even, rapid cure.

Next the lower sand leaves turn bright yellow, the tips of the wrapper leaves do the same, and yellow patches appear on the surface of the wrappers. A little later the sand leaves begin to turn brown. They come to their color soonest, but the process goes on gradually all through the plant, till, last of all, the top leaves are cured.

But all this time the stems, the midribs of the leaves, remain yellow and full of sap, and, at this stage of the cure, easily break from the stalk. On further drying they turn brown at the point of union with the stalk and knit onto it, so that they break off much less readily than before.

Drying the stems is the last and most tedious part of the process. The sap dries up very slowly, but finally the stem shrivels together, and the crop is ready to dampen up and strip.

This fairly describes the cure when it goes on just as the grower could wish, with no bad weather, with no hitches of any sort. But you all know that it does not fairly describe the curing process as it goes, in nineteen cases out of every twenty. Curing time is an anxious time for *all* growers, no matter how much experience they have had. Much depends on skill in taking advantage of, or in dodging, the changes of the weather : anticipating a long storm, for instance, by drying out the crop a little more than one would otherwise ; changing the air in pole-burn weather by burning kerosene lamps under the tobacco, or even kindling wood fires. But there are some seasons when, in spite of all skill and painstaking, crops are ruined or badly damaged because of bad weather after harvest. *Every* year

there is danger. *Every* year there is some poorly cured tobacco, and every year there are many crops which would sell better if they had not been damaged in the barn.

If, as sometimes happens, a wet, foggy spell follows harvest, before the crop has thoroughly wilted, the plants "full up," which means that water is pumped from the stalks into the leaves faster than it can dry off into the air, so they become filled and turgid and stand off from the stem, as they do when they are growing in the field. This stops all circulation of air between the lath. And what have you? A lot of vegetable matter in a dark place, saturated with moisture, no circulation of air, and summer heat. The ideal conditions for a manure pile, but a mighty poor outlook for tobacco.

It soon gets a strong, ugly smell, and mould sets in; or, if this condition of things happens a little later in the process, pole-burn is sure to follow. But, if the weather comes off clear, it takes much longer to get the leaves wilted than it did to wilt them at first, because of the general blockade of all the air passages through the tobacco.

Another trouble, not as much feared because not as evident during the cure, and perhaps not as disastrous, is "white vein." We believe it is caused by a too rapid cure, particularly in the purline, when the weather during the early part of the cure is hot and dry.

There is a third source of danger, damage and loss, which is still less commonly regarded than the other two. I mean the moulding of the stem. To completely cure the stem takes much longer than to cure the rest of the leaf, and during this long time it wets and dries a good many times, with the changes in the weather. As a consequence, the stem often moulds more or less, sometimes very badly, and the trouble spreads into the leaf tissue and rots it more or less. A little mould is thought nothing of. Any considerable amount of mould is, however, a loss to the farmer, for it destroys a portion of the stem, which would otherwise dampen up at stripping time and increase the weight of the crop. It is a damage to the leaf from the packer's point of view, also, for it infects it with mould spores, which are likely to make the tobacco mouldy or musty in the case.

Now, all these various faults in curing, as I have already said, can *often* be wholly or largely avoided by skill and watchfulness. They cannot be wholly avoided in most seasons; they seriously damage or wholly destroy crops in *some* seasons. It follows, then, that the present way of curing is imperfect. It sometimes, often, let us say, turns out unsound tobacco. It does not make out of the crop all that might be made out of it in all cases, and to do *just that*—to make the best possible thing out of our leaf—is what we are after.

Is it, then, possible to improve our method, so as to avoid pole-burn, white vein and stem rot or mould, and get the required quality as regards color, elasticity, etc.? That is the question on which we have worked for the last two years, and successfully, too, in spite of our disaster.

The further question we have not yet got at, viz., can an improved system be used in our barns, built as they are?

It *is* possible to avoid danger of pole-burn, of white vein (so far as this is caused by too rapid cure) and stem rot, or mould, and to produce perfectly sound cured leaves, by applying heat at the proper times to barns in which tobacco is hung in the usual way—that is, on the stalk—for curing. We have done it, so we know of what we speak.

What, now, do we mean by artificial curing, or curing by artificial heat? There is a common impression that this means keeping the tobacco at a high, moist heat during the cure, and implies a cooking or steaming of the leaf, with a final dry roasting, which leaves it of the right color, perhaps, but without flavor and elasticity or “life.”

All this is precisely what we do not want to do and what we do not do with artificial heat. The only guide in curing tobacco, either with or without heat, is the look and feel of the leaf. No special skill or knowledge is needed for it beyond what every skilful tobacco grower has.

In our own experiments of the last two years we have endeavored to follow these rules:—

Never let the air in the barn get as hot as it sometimes does in a curing barn in the purline. It never went higher than 87° and seldom over 82°. You cannot talk of “cooking” tobacco at that heat.

Keep the heat uniform all through the barn. Our purline averaged only 3 degrees warmer than the lower tiers.

Never let the tobacco get chilled. The lowest point it ever reached in the barn was 59° , and it averaged 69° at 3 to 6 o'clock in the morning, the coldest time in the twenty-four hours.

Never let the green or yellow leaves dry out so as to be anywhere near dry and husky. Keep them sappy, but limp, so they will hang like rags at the tips. This may sound hard to do, but it is easy. The sand leaves or seconds and then the second wrappers may be allowed to get a little husky after they have come to color, but never let them get chippy or brittle.

And, finally, keep the tobacco moving on in the cure day and night. Don't let it stop and hang fire, as it often does in the barn, waiting for some change of weather to send it along again.

In 1897, after we had successfully cured a small crop, our barn was destroyed by fire. In 1898 we put up a new barn, with a system of heating which is perfectly safe. A single chimney is built in the centre of the barn, running through the roof close to the ridge pole.

Two furnaces, one on each side of the barn, outside of it and covered by a lean-to, supply the heat. Each sheet-iron furnace is surrounded by a brick wall, having an air space five inches wide between. From this two hot-air pipes pass into the barn, one going nearly to each end and then returning to the chimney, having enough pitch to secure the flow of hot air in them. The smoke and hot air from the fires can also be turned into these hot-air flues, when desired. This year we had a rather inferior crop to cure, which had been pinched by dry weather. We do not recommend our own method of heating for general use, our experiments have not gone far enough for that; but it is perfectly certain that artificial heat in some form can be used, at least occasionally, in curing-barns and entirely prevent the ravages of pole-burn in unfavorable seasons.

If I were a grower, I certainly would not go through a single season without a supply of kerosene lanterns, at least to use in emergency, to change the air in my sheds in bad

weather. I have seen small kerosene stoves do excellent service, but your factory at Florence could make, if there were a demand for it, a cheap kerosene lamp, without glass, to burn twelve hours, and which would not flare or go out in any moderate wind.

In general, I may say that the plan which we have followed cures the leaf in much less time than the usual method, absolutely protects it from pole-burn or stem rot, and that the leaf so cured cannot be distinguished from the leaf perfectly cured by the ordinary process.

We shall continue our work on this line, I hope, till we have found the best way of applying heat to tobacco in barns built as is usual in the Connecticut valley.

These are some of the things which we, farmers and station men, have worked out together. They are things which we know as the result of experience and observation. It would take longer to tell of the things we don't know. It seems to me that one of our *greatest* deficiencies is our ignorance regarding the sweating or fermenting of the leaf. We do not know what special organisms cause it, what changes it makes in the substance of the leaf, nor how to regulate it in any way.

Our system consists in nailing the tobacco up in cases, letting them stand over one summer, moving them once, perhaps, during the time, and then taking the tobacco out, sometimes well sweated, sometimes poorly sweated; sometimes rotted, or musty, or mouldy, or with "canker."

Can't we do better than this? One of the objects for which our Tobacco Experiment Company was organized, six years ago, was to study this matter. We have begun on it, with the advice and help of practical tobacco packers. Other stations, I believe, purpose to take it up, and the United States Department of Agriculture is asking Congress for a special appropriation, to be used in studying methods of fermenting tobacco at home and abroad. All this is in the right direction.

The quality of the leaf is determined in the end by the nature of the fermentation. We must know what this fermentation is, what it does to the leaf and how to regulate it. If it is the work of microbes, and I have no doubt that

it is, we must learn what microbes to admit and what to exclude from the fermenting leaf, and what are the conditions, as regards heat, moisture and air supply, which are favorable to the kind which we want and unfavorable to other harmful kinds of fermentation.

This will all come in good time, but we want it to come first and best in New England. Competition is strong within and without our own country, and we want to remember that neither an established reputation nor an established trade, nor a protective tariff can protect us against goods of superior quality from without. The sure way to keep our trade is by constant advance in the matter of economies in labor, and in marketing our crop; in methods of growing, curing and fermenting; in all knowledge, in short, which has any bearing on our particular line of business, — the growing of wrapper leaf tobacco.

The CHAIRMAN. You have heard the able address, and it seems as though the subject was almost exhausted, but Dr. Jenkins invites your questions. We hope some of the experiences of the experts of this vicinity may be given. To illustrate: A daughter goes away to school and her mother advises her to write home all about everything there. She writes a long, exhaustive letter, and then says, "If you wish to know anything more, ask questions." So the meeting is yours.

Dr. J. B. LINDSEY (of Amherst). Had that fish very much oil in it?

Dr. JENKINS. It was the ordinary dry fish scrap that is used as a fertilizer. I suppose it would have fifteen per cent of oil.

QUESTION. That oil did not seem to have any effect?

Dr. JENKINS. No, it did not.

Mr. ——. I have heard it claimed that it was very valuable as a fertilizer.

Dr. JENKINS. Yes, you will find plenty of the farmers along the shore who claim that it makes a good fertilizer, that it makes a "slick" crop. They say they do not care anything about the nitrogen.

QUESTION. Did the fish make any darker leaf or darker quality?

Dr. JENKINS. No, there was very little difference in the wrappers. The burning quality, texture and all that sort of thing were better than cotton-seed meal.

QUESTION. Your stable manure is not horse manure?

Dr. JENKINS. No, we could not get the clear New York horse manure, though there was a large proportion of horses in the stables which furnished it.

Prof. W. P. BROOKS (of Amherst). I know very little about tobacco, either through experience in raising it or using it, but one or two thoughts have occurred to me upon which I would like light. He has said that the quality of the plots differs from year to year on the same fertilizer. I am quite ready to believe that. It is not only possible, but probable. But a point on which I want light is, are the differences between the tobacco sufficiently marked to make the judgment certain? Another point is, has the tobacco been judged each year by the same individuals? In the case of that which ranks 1st one year and 14th another, I have wondered whether the difference has been due to personal equation.

Dr. JENKINS. I am glad these questions have been raised. I ought to have said the difference between the plots as graded at times was very small, so that in some cases it was difficult to say whether it should be graded 1st or 5th, but there was a great difference between that which was best and that which was worst. It was the only method that we could follow to have them graded strictly according to their relative value. Sometimes there would be as many as five or six which the expert would say were so nearly alike that it was very difficult to distinguish between them; that another man might make a different judgment. It was done each year by the same man, so the personal equation is eliminated. It is very difficult to say to what the differences were due.

Mr. GEO. P. SMITH (of Sunderland). How many lanterns or oil stoves would be required for the crop of an acre of tobacco?

Dr. JENKINS. That is a point we have not determined. We have only been working at it for two years. We have a barn in which we put the yield of two acres of tobacco, and I think we burned in curing that about a cord and a half of wood, but I presume we could have done it more economically than that. As to the number of lanterns, I cannot give you any idea.

Mr. SMITH. How long do you keep up the heat?

Dr. JENKINS. Only during the time while the danger exists. If you have a hot, foggy, muggy time, with no air stirring, keep them burning until there is a change in the weather, so that you can open up the barns. The lanterns are a temporary make-shift. I have seen tobacco that looked pretty ugly at night — just beginning to smell a little “off” — brought into condition in twelve hours, so that it would be all right, by putting these lanterns into the barns. We use artificial heat in our experimental barn, and keep the heat going nearly all the time. We do not recommend using it as a substitute for good air, but to supplement the air and sunlight and keep a Florida climate in the barn all the time, whether it rains or shines outside.

Prof. C. H. FERNALD (of Amherst). Do you have any trouble with tobacco insects?

Dr. JENKINS. Yes, we are troubled with insects of all sorts. Even in curing by artificial heat the insects trouble us. I slept in a tobacco barn a week to watch the tobacco, and I was troubled with the long green “Polander” worm that drops down into your ears while you sleep. We have had continual trouble with cut-worms, and have tried various things to get rid of them. One year we had good results by keeping the land clear of weeds, and within ten days of setting we gave the worms a big Thanksgiving feast. We took about five hundred pounds of bran and five pounds of Paris green and stirred them up and made a Paris green mash, and then sent a boy over the field — it had been rowed out — to drop handfuls, a pace or two apart, on the tobacco rows. The worms took to the food and we killed thousands of them. We set our tobacco within a few days, and were not troubled at all with cut-worms. Since then our man has tried the same thing, and it has not succeeded as well. I wish you

could give us some suggestions. The cut-worms trouble us the most. The tobacco worm, which is called the "Polander" worm because a Pole is the only man who likes to pick them by hand, also troubles us. These are the only two insects that have troubled us much. Have you any suggestions in regard to cut-worms?

Professor FERNALD. Before answering your question, I would like to inquire if you have a flea beetle which makes minute holes through the leaves?

Dr. JENKINS. Yes, we have been somewhat troubled with that, but not seriously. The lower leaves, the sand leaves, are more apt to be punctured than the first and second wrappers, but we have not been seriously troubled with them. I imagine they are harder to fight than almost any other pest. I would like to hear from you.

Professor FERNALD. I am sorry that I am not able to say as much as you would like on this subject. In some States there have been quite extensive investigations on tobacco insects. In regard to the "Polander" worm, I do not know of any other method than hand-picking. If the Polander picks them best, get the Polander. In regard to the cut-worm, I have never seen in print anywhere whether there is more than one kind of cut-worm that troubles tobacco. We always speak of them as cut-worms, but there are several hundred species, and if we have more than one kind on tobacco, a remedy that was good for one might not be good for another. I have bred one species, and I know it breeds on many other plants as well. If we are to make a recommendation, it is necessary first to know just what we are dealing with.

Dr. JENKINS. I supposed there might be a considerable number of different species belonging to that class. I am nothing of an entomologist myself.

Professor FERNALD. There has been but one kind sent here, and whether there are other kinds attacking the tobacco I do not know. In our State they simply call it the cut-worm, which is a very simple thing.

QUESTION. You spoke of the long time the land is vacant. How would it be to rotate and get a crop of grass? That would do away with the land being idle.

Dr. JENKINS. We find it is a disadvantage to try rotating or taking up new land. About Hartford and Suffield that is the feeling of all growers. We cannot expect a first-class crop on new land. We have fields on which tobacco has been grown for forty years, and it is of the best quality. We find it a damage to try rotation. Stick to tobacco. In Sumatra they cut down the jungle and put in tobacco for a year, and then let it go back to jungle for several years. They are having some trouble in Florida with raising tobacco on the same land year after year. Here we raise it on the same land to the best advantage.

Mr. DEXTER HAGER (of Whately). The cut-worm is the greatest insect enemy we have in this region, I think. I wish some one could tell when the egg is laid in the soil. I was informed by Cyrus Hubbard that if we kept the land perfectly clear of weeds all through the autumn there would be very little trouble from cut-worms. He alleged that the insect laying the egg was guided by its instinct to places where vegetation existed. I followed his advice, and we have had very little trouble since.

The CHAIRMAN. Will Professor Fernald give his opinion?

Professor FERNALD. If I should say anything in this matter, it would be a conjecture from what I know of all cut-worms. Until I have exact knowledge of the insect, I feel that I had better not say anything.

Secretary SESSIONS. Would the Professor like the insects sent in next year?

Professor FERNALD. If there is a demand for information, I shall be glad to study this insect.

Mr. HALSEA SEARLE (of Northampton). I would like to ask the Doctor if in damp weather he opens his sheds for pole sweat.

Dr. JENKINS. At such a time, whichever way you do, you wish you had done the opposite. The conditions outside the shed and inside are so nearly alike that you cannot change the air. Everything is absolutely dead. If you put lamps in the shed you can dry the air and get a circulation so that there is a chance of getting the water away from the leaves.

Mr. SEARLE. Of course you would close the shed in that case?

Dr. JENKINS. Yes, but I would open it up above. I would place the lanterns at the bottom, and then you would have a chimney. Circulation will begin to dry the tobacco, and that is what you want to do.

Mr. SMITH. Have experiments been tried in spotting tobacco?

Dr. JENKINS. There has been a lot of fine tobacco ruined by it. We are praying that the fad will go over this year, so we will not have to spray for the spot next year. It is hard to get an arrangement to put on the spot as you want it. We got a Vermorel sprayer, and by fixing the nozzle we did what was called excellent work. Any one who sprays for the spot is likely to be prosecuted for infringement of patent. One suit has been brought in Connecticut, and we hope it will be tried this winter. It imitates the Sumatra spot, and I do not think the patent will stand. It would not be wise to undertake to spot tobacco until that suit has been decided. I hope the fad will blow over before another year.

The CHAIRMAN. We have some expert tobacco growers here, and I wish we might hear from some of them. Their experiences have covered many years, and they have been getting fine crops and great prices. Mr. Newhall of Conway has sold a good crop, and does not tell how much he got, because he got so much.

Mr. J. C. NEWHALL. I think the raising of the tobacco crop is a lottery. One year you raise a good crop and the next year you do not, and you cannot tell what makes the difference. We have had more heat this year than was needed. There is no pole sweat here, it is somewhere else. Would not very late ploughing before cold weather sets in use up the cut-worms by destroying the egg or larva? The lecturer spoke of putting on middlings and Paris green. We go over ours and give each plant a dose of the dry dust.

Dr. JENKINS. Did it set the plants back?

Mr. NEWHALL. I do not know that it did. I think it used

up a great many of the cut-worms. It is hard to get rid of them. I do not know as there is any remedy for the flea beetle. They make a tobacco leaf look like a sieve in a very little while. I raise tobacco and sell it for about the same as other people, I suppose.

Secretary SESSIONS. Is your soil like that described by the Doctor?

Mr. NEWHALL. I think ours is perhaps a little heavier than that in Connecticut.

Dr. JENKINS. What do you use for fertilizer?

Mr. NEWHALL. Manure. I keep on the farm from fifty to sixty head of cattle, and we use most of the manure and fill up with different kinds of fertilizers. The worst pest we have is fertilizer agents, and to get rid of them we buy some of their fertilizer. A gentleman came around and looked at my tobacco, and I threw out one bundle, and I was very sorry that I threw that bundle out, for it looked so bad I wished the gentleman had not seen it. I threw out another that I thought was much better. He began to talk about the price, and said if it was all like the first bundle he would buy it very quickly. We always have what they do not want and seldom have what they do want.

The CHAIRMAN. Mr. Whitmore of Sunderland came in after we commenced, and we would like to hear from him.

Mr. F. W. WHITMORE. I do not know as I can say anything to instruct this audience. I have been growing tobacco for thirty years, and I am surprised every year with my ignorance of the methods. Whatever sort of a crop we have, it is never right. If we have dark, the agents want light. The buyers are not always the pleasantest men to deal with. I wish I had never embarked in the business. It is a dog's life. An old neighbor of mine said it required thirteen months in a year to raise tobacco, — twelve months for labor and one month for anxiety. As has been said, it is a lottery. This year we were very successful. I suppose I shall be foolish enough to raise tobacco, hoping to have a repetition of this year's success. If we had a little more information as to what fertilizers to use and the proportion in which to use them, it would be to our advantage; but it is with us as

it is with our clocks, none of them go just alike, so what is good medicine for my soil is not for some one's else.

My experience has led me to grow my tobacco on a soil containing much more moisture than we have been hearing about to-day. The labor of starting a crop on these light soils is quite an item with us, while on a soil containing more moisture the expense is comparatively nothing. With the tobacco planter we now use it is not hard to start a crop. My experience is that we get better quality in the long run on a soil that contains more moisture. I was offered just twice as much for tobacco grown on heavy soil as for that grown on light soil. But it did not work that way every year. In a series of years my experience has been that the heavier soil is the best.

Last year the tobacco turned yellow in the field, and we applied nitrate of soda at the rate of 150 pounds to the acre about the time of topping. It had the effect of turning the tobacco darker in the field, and also caused it to be darker when cured. On the whole, I considered the nitrate of soda a damage rather than a benefit. We have practiced sowing rye, with very good results.

Dr. LINDSEY. Is it practical to sow clover instead of rye?

Dr. JENKINS. I should say it would be a better crop on many accounts, if you could get it to catch.

Dr. LINDSEY. The crimson clover has not been very successful. The red has done quite well. The tobacco might shade the ground so the clover would not catch.

Dr. JENKINS. We tried clover for two years, sowing it immediately after we got the crop of tobacco off; that made it come about the middle of August, but we did not get a good catch either year. What came up "winter-killed" in the spring. It would be a good idea to sow red or crimson clover, if you could get a good catch. You need not be afraid of its taking too much moisture from the soil. Has any one tried casing his own crop, — holding it until it has fermented?

The CHAIRMAN. Some of us have.

Mr. WILLIAMS (of Deerfield). In preparing the soil for seed, would you plough the fertilizer in in the fall or in the spring, or in what manner do you make up the bed?

Dr. JENKINS. I would rather hear what you have to say about that.

Mr. WILLIAMS. My experience is somewhat limited, but the manner in which we have treated our soil for our tobacco bed for the past two years—and we have been quite successful in getting plants early—is to apply nothing in the fall but cotton-seed meal, at the rate of 100 pounds to the square rod, and harrow it in thoroughly and rake and roll the bed and prepare it as you would in the spring before sowing seed, and then as soon as the frost is out of the ground in the spring, rake the bed with an iron rake, then rake it again, still lighter if possible, and roll it and put on the glass. We use no fertilizer until the plants are up, then we use nitrate of soda or some special tobacco starter. We put on the water warmed to from 80° to 95°.

Dr. JENKINS. You start your seed in jars with some vegetable mould?

Mr. WILLIAMS. About half of the seed. That is done by taking an old-fashioned milk pan and filling it about half full of loam, and then put on a cloth and cut a turf the shape of the pan and keep it warm and moist.

Dr. LINDSEY. As to the relative merits of the different forms of potash, we find that the tobacco men as a rule are obliged to use sulphate of potash. Can the farmer get carbonate of potash sufficiently cheap so that he can afford to use it? What would you advise farmers to apply as a carbonate?

Dr. JENKINS. Cotton-seed hull ashes, if you can get them cheaply; if not, wood ashes. We have first-rate results from wood ashes. There is no better form of potash than wood ashes. I think the carbonate of potash made by the potash syndicate is pretty expensive. We are practically limited to these two forms,—cotton-seed hull and wood ashes. If you make allowance for lime in the ashes, they do not cost much more than any high-grade sulphate. High-grade sulphate costs from five to five and one-half, sometimes more. In ashes you ought to have 5 per cent of potash, that is, 100 pounds to the ton. You want two or three tons of ashes to the acre.

Dr. LINDSEY. Do you think it would be better to use carbonate rather than sulphate for economy and effect?

Dr. JENKINS. I should for growing it myself. Growers in Connecticut not far from our experimental field think that high-grade sulphate does not give good results. When I spoke to them of the results of these five years' experiments, I had about five hundred cigars offered me, to disprove my statements. I regret I have not a hundred now. What I give you is just the results of our experiments on our fields.

QUESTION. How about using double sulphate?

Dr. JENKINS. In our experiments we got better results and the quality was better where we used double sulphate.

Professor BROOKS. I have within the past year received from the potash syndicate considerable matter pertaining to the new form of potash, silicate. The results of experiments in Germany seem to speak very favorably indeed of this new silicate. I would like to ask Dr. Jenkins if he has begun experiments with it, and to express an opinion, if he is willing, as to the probabilities of the value of this new form of potash. Has the question of its value to tobacco growers been settled? As yet the price is rather high.

Dr. JENKINS. We gave up our experiments with fertilizers two years ago to take up experiments with tobacco. Mr. Du Bon has tried silicate during the past year, and, while the tobacco has not yet been through the sweat, its present appearance is very favorable. It looks as good as any leaf grown with other fertilizers, but I would not say that it is superior to the others. Final judgment cannot be given until after it has been through fermentation.

Mr. GEORGE SEARLE (of Easthampton). Do wood ashes have anything to do with pole burn?

Dr. JENKINS. No, I do not believe they can have the slightest effect. We know pole burn is a bacterial trouble. I cannot imagine that the fertilizers would have the slightest influence on it.

Adjourned at 12.15 P.M.

AFTERNOON SESSION.

The meeting was called together at 2 P.M. by the secretary, who said : —

You have all noticed what our subject is for this afternoon. President Goodell has been asked to preside this afternoon.

PRESIDENT GOODELL. The address this afternoon is one that will interest you all. It is on "The mission of the agricultural colleges." The speaker who has been chosen to address you is one who has had wide experience with different colleges, having been connected with the State College of Pennsylvania, with the University of Maine and also with the Wesleyan University at Middletown, Conn. I have the pleasure of introducing to you Dr. Jordan, director of the Experiment Station at Geneva, N. Y.

THE MISSION OF THE AGRICULTURAL COLLEGES.

BY DR. W. H. JORDAN, GENEVA, N. Y.

This meeting of the Massachusetts Board of Agriculture is to me an occasion of great significance. You who are here may have thought of it as not unlike other meetings, neither greater nor less. I ask your indulgence, nevertheless, while I present to you what lies in my mind as the real meaning and the far-reaching relations of this event.

First of all, this is a college town, one whose name is familiar wherever in this land ambitious young manhood is scanning the opportunities offered to American boys for acquiring an education either in the liberal arts or in the sciences. You have here the refinement of thought, the intellectual activities and that general uplift of mind and heart, which are so generally characteristic of the social status in a community dominated by college influence. Moreover, this is a New England town, a Massachusetts town, which means that it is in the very midst of a people imbued with a love of learning, whose fireside traditions have been the inspiration of many sons and daughters when they have turned their faces toward the school or the college. The history of our progress, moral and intellectual, can certainly not ignore, and some of us can never forget, those examples of labor and of sacrifice exhibited by New England homes in order that sons and daughters might stand in the forefront of opportunity for acquiring a larger stature of mind and soul. How immeasurably is this new republic indebted to the aspirations of the common people who have lived and who still live in this small group of our smaller States! I do not flatter when I declare that such a community as this is one of the springs that feed the current of good in business and social life which makes for the salvation of our nation.

With such an environment, the possessors of such traditions, you are met together. And what is this assemblage? It represents the agriculture of Massachusetts, and herein lies the significance of the situation. The college and the farmer have joined hands. This close sympathy and relation between the higher range of intellectual thought and effort and a board which is the official representative of a great industry symbolizes the remarkable change that has come to school and college education during the latter part of the nineteenth century. Our knowledge is not only vastly modified in kind, but its use is directed to ends greatly different from those formerly sought. Education in literature, philosophy and the sciences is now more than a luxury, more than the possession of the recluse, more than the necessary equipment for the old-time professions; it has become essential to modern industrial life and a potent factor in industrial progress.

I will not burden your thought at this time by presenting the statistics of this attempt at training our young men and women in the sciences that relate to the various arts and to the common affairs of life. Suffice it to say that millions of dollars, hundreds of teachers and investigators and thousands of students are involved in this effort to understand and control the energies of the material world, in order that we may live and labor in harmony with nature's laws. The means for carrying on this great educational and research movement in the United States are largely supplied by the national and State governments. As a rule, the intelligent masses are in sympathy with this use of public funds. This thing has not been done in a corner, but after a full and free discussion by the press and from the platform. Congress and State Legislatures have been repeatedly memorialized in behalf of appropriations to the colleges of agriculture and the mechanic arts and to experiment stations; and, so far as I know, there is no disposition among the people to turn back from the road which we are now travelling. The disposition is rather to enlarge and perfect the facilities for teaching applied science and for the discovery of new truths.

While we recognize this somewhat general demand for government aid to technical education and an assent to a

generous use of public funds for this purpose, we are well aware that the workers in the field of agricultural education are and always have been forced occasionally to assume an attitude of defence. The utility, the methods and the results of the agricultural college effort have been the mark of serious and continued criticism, much of which has come from farmers. In this respect the agricultural departments of State colleges have stood in marked contrast to the departments of engineering, whose administration and progress as a rule have been unmarked by disturbing or unfriendly comment even from their own constituency. It may be declared, without fear of controversy, I am sure, that in the history of the land-grant colleges not only has the great burden of criticism rested upon the agricultural departments, but those departments have faced problems of administration and method more severe and perplexing than have been met in any other associated lines of instruction. Persistent hostility and loyal support, ignorant criticism and intelligent, courageous defence, mistaken efforts and well-directed, successful methods have all been factors in the experiences and steady progress of agricultural education during more than a quarter of a century. But after all these years, in spite of all the triumphs that are ours and notwithstanding the abundant justification for the establishment and maintenance of agricultural colleges and experiment stations which is shown by the changed status of agriculture, criticism still exists, serious problems are yet unsolved, and in some respects results are yet far from satisfactory.

These criticisms and the problems of administration and method may be grouped around three assertions that often appear in print:—

1. Few students enter the agricultural courses, and fewer return to the farm after the completion of their studies.
2. The college course educates a man away from the farm.
3. The courses in agriculture are not sufficiently practical.

The last of the three objections which I have named as being commonly urged against the courses in agriculture I

shall not discuss specifically. Under another head I shall try to defend what have been settled upon as the essentials of these courses. I will only remark at this point that in my judgment the average farmer's son who graduates from your college is as well fitted to enter upon the successful management of a farm as is the raw graduate from the medical school to treat a case of typhoid fever or any other serious disease. It was facetiously remarked to me not long since that "The farmer and the doctor are alike in one respect,—the soil covers the mistakes of both." How many errors of knowledge and judgment lie buried in mother earth we may never know.

Let us now consider the first two assertions in the order in which they are stated. Do not suppose, however, that in presenting my views at this time I claim to speak *ex-cathedra*. I shall only give to you the convictions that have come to me since I entered one of these institutions twenty-eight years ago, during which time, as student, teacher and station director, I have been almost continuously in touch with this new educational effort. Permit me also to suggest at this point that it is wise to discuss this matter in the frankest manner. I fear that some of us have been cherishing delusions, and that we have even avoided facing in their true light the conditions and problems that pertain to agricultural education. We cannot afford to retain this attitude. The situation demands that prejudice and considerations of expediency shall no longer prevent a full and free recognition of the actual facts that are involved in the efforts of education and research to which some of us are giving earnest conscientious attention. We should no longer reject the lessons of experience, and thereby delay real progress.

First of all, then, it is an undisputed fact that comparatively few young men do enter the full courses of agriculture that lead to a degree, and fewer that graduate adopt practical agriculture as their main life work. This being the case, it is important for us to know the reasons for such a condition. Where shall we seek for an explanation,—in the colleges, or elsewhere? Are there scores of young men hungering to be properly instructed in the relation of

science to the art of agriculture, who are discouraged by the inefficiency of agricultural colleges, and so hold aloof; or must we grant that these institutions are offering valuable instruction of the right kind, and then seek in other directions for an explanation of the meager number of students? Should we not inquire what is the influence of business and social conditions, the prevalent ideals of success and the possibilities that open before the American boy? The critic usually assumes that the colleges themselves are responsible for the small attendance upon the courses in agriculture, because these courses either are not what they should be, or else, which is the more common claim, because the atmosphere of the college is not sympathetic to agriculture. Is such an assumption just? Is it in accordance with facts?

My conviction, born of observation and experience, is that in the main these colleges cannot justly be blamed for the small proportion of students of agriculture who have entered their doors. There are in this audience many persons, doubtless, who have been teachers in the rural schools of this and other New England States. Those of you who have had this experience will agree to the statement, I am sure, that only a part and perhaps a minority of farmers' boys could by any known means be induced to enter upon a course of study worthy to appear in a college catalogue as leading to a degree. The majority of them have neither the aptitude nor the inclination that are essential to successful study in the higher branches of learning. Listen to what Maclaren writes of Domsie: "But it was Latin Domsie hunted for as for fine gold, and when he found a smack of it in a lad he rejoiced openly." In a minor proportion of country lads do our teachers find a smack of that love of learning which in some degree is absolutely essential as a motive for overcoming the obstacles which lie in the path of the college student. These unscholarlike boys may become successful farmers or business men, but not even passable students of advanced subjects; and therefore they are not available material with which to fill the class room of any college whatever. Their education must come from other sources.

Many farmer's sons — and it is a notable proportion in New England, as compared with other sections of our country — do, however, possess in a varying measure the desire and the ability to acquire knowledge beyond that supplied by the common school. We speak of these young men as ambitious. But what are their ambitions? They are, as a rule, just what we should expect them to be. As these boys sit around the home fireside, many of them listen to the exaltation of riches, professional skill, official power and forensic or literary distinction as the highest attainments. The volumes of the histories of men and of nations which they thumb tell them, not of farmers, but of legislators, orators and poets. These dreaming, ambitious lads, when they look across future years to the shining delectable mountains which they mean to climb, see visions, not of the humble farm, but of the counting room, the physician's office, the halls of legislation, the forum or the pulpit. Possibly when in later years they shall stand in the valley of disappointment, or when from some height of power or distinction, hungry for peace and rest, their thought returns to the deserted farm, here and there one may wonder why some wise soul had not shown him more clearly the values that are real. But the eager youth does not possess the clear vision of maturer age, and so, stirred to action by the story of the ages, he joins in the race for distinction.

Now it does not appear, so far as I have been able to observe, that the fathers and mothers on the farm are as a rule out of sympathy with the course which their sons pursue in seeking distinction where distinction has always been found. The critic of agricultural colleges is prone to assume that farmers and farmers' wives are anxious for their bright boys to stay on the farm; but I do not so interpret their pride in the career of the merchant, physician, lawyer or clergyman, whose college education was made possible through their hard work and persistent economy. I have found from a knowledge of individual cases that this defection from the ranks of agriculture is regarded with the utmost complacency, even satisfaction, not only in the homes most interested but by the rural communities that take great pride in the successful men they have sent into the business or professional

world. As a matter of fact, it is everywhere conceded that a young man should choose the largest opportunity for success which opens before him; and, with the prevailing standards of success, what can we expect?

But, granting that a proportion of farmers' sons, who are fit material for the developing and moulding influences of the college class room, are disposed to adopt agriculture as their life work, there are still reasons why even many of these have not been inclined to attend the agricultural college, chief of which has been an inappreciation of the value of science in practical agriculture. Twenty-five years ago there was a general attitude of skepticism towards the so-called scientific farming, or book farming, as it was sneeringly termed. While this attitude has been modified, you will still find, if at farmers' institutes you enter into conversation with young men, prospective farmers with a good outlook, that they have serious doubts whether after all it will really pay to spend four years at the agricultural college in preparation for the life of a farmer. One cause of this doubt is that these young men have no conception of scientific truth or its value. They have not turned the first page of the book of nature. They have never been shown the law and order that are everywhere about them, and therefore they do not see how surely added power comes to any man's life when he can understandingly control and direct the forces of nature. The early home training in part, but more especially the common school training, has been responsible for this ignorance about the most important part of human knowledge.

It was into the midst of such an environment that thirty years ago the agricultural colleges were projected, with all the traditions of education and ideals of success opposed to the new proposition that the future farmer should be a college man. Ignorance of facts and methods existed on every hand, and there were no examples which could be used as object lessons in illustrating the value of scientific knowledge to agriculture. The colleges of agriculture have not only had laid upon them the burden of teaching applied science in a satisfactory manner, but also the greater task of creating a demand for the education which they have offered. These

institutions have been centres of missionary effort. They have even been like that certain man who when his invitations to the wedding feast were ignored sent into the byways and highways and compelled his guests to come in.

There is little occasion for wonder, then, that so few students have been graduated from courses in agriculture in the New England States. To be sure, your own institution has been a somewhat notable exception to the experience of others, as has the Michigan Agricultural College in the west. Doubtless this success is due in part to the fine equipment and excellent management of these two colleges, but also in part to the fact that no other technical courses of study have come into competition with the agricultural course, as has been the case in other States. But this very failure of the agricultural course to endure competition substantiates what I have been saying concerning the influence of prevailing views and ideals. Do not suppose that I propose to measure the value in success of agricultural colleges merely by the number of their graduates that are farmers. I shall refer later to other benefits.

In the second place, the charge is often made that agricultural colleges educate men away from the farm. Only a few days ago I heard the president of a prominent western university use the phrase, "educate young men away from the farm," as though he regarded it as significant. But what is meant by not "educating young men away from the farm?" Does it mean that mental development and culture must be limited, in order that the students' ambitions may not be aroused to seek other callings? Or that the curriculum of study should be devoid of certain features, so that the student may be kept ignorant of fields of thought and mental growth outside of agriculture? Or does the critic intend to assert that, if the subject matter of the courses of agriculture was sufficiently practical, and if the spirit of the instructors was thoroughly in harmony with farming as a calling, young men would be led to love the farm and its environment?

There is little ground for the suggestion that the teachers in New England agricultural colleges are not sympathetic towards their students returning to the farm. No one acquainted with these men, especially those who teach distine-

tively agricultural subjects, could hold such an opinion of them. Motives of policy, if no others prevailed, would lead them to desire results which the public expects. If there is fault anywhere within the colleges, it must be chiefly with the courses of study. Let us consider these.

The most carefully elaborated of such courses with which I am familiar are based upon three fundamental propositions:—

1. That all young men in college should be taught something of languages, political science and philosophy.

2. That thorough and extended instruction should be given in the natural sciences.

3. That the technical instruction should consist mainly in pointing out the relations and applications of science to agriculture, with more or less training in certain expert methods.

It is important to test the soundness of these fundamental propositions, because, if they are defensible, we are bound to accept the consequences of their adoption. Regarding the first proposition, that the agricultural college student shall be trained in the art of speaking and writing, and be made acquainted with the refinements of thought, the principles of sociology and government and the conclusions of philosophy that relate to his intellectual and spiritual being, we may practically epitomize all argument by asking one or two questions:—

Will the intelligent agricultural masses consent, even in theory, to divorce their calling from a knowledge of those intellectual and spiritual conceptions which are the glory of the human mind and soul? Are they willing to be set apart as a people who are unworthy of some of the best things that human reason and human experiences have to offer, but with which the followers of other callings are free to enrich their lives? In short, so far as the man side, the culture side of education is concerned, shall we, as a fundamental concept, distinguish between one class and another in our educational means and methods? These questions need no reply from me. The common judgment of humanity has answered them long ago. We are bound to freely open to all young men who seek college halls the

storehouse of thought and knowledge, in order that, without regard to their proposed callings, they may understand their political, intellectual and spiritual relations.

Again, shall we train the four-years agricultural college student severely in the sciences? We must, or fail of our purpose. Pedagogically speaking, it is impossible to successfully teach the application of the sciences to the arts without a previous knowledge on the part of the pupil of the fundamental principles and facts of the sciences themselves. It is for this reason that short-course students of agriculture are so serious a problem to the teacher. Some men who pretend to teach or practice agricultural science, but who are ignorant of fundamentals, are like a ship without a rudder, — one never knows where they will land.

Finally, as now organized, the courses in agriculture differ from those in engineering in that the former involve less of mechanical manipulation but depend more for their value upon a discussion of the relations of science to agricultural operations. Agriculture as an art involves a minimum of expert mechanical work. The success of the farmer consists not so much in the skill of his hands as in the ability to place the soil and fertilizers and crops and foods and animals in their right relations, — to avoid, in other words, the violation of natural law. Aside from a few expert processes, the mechanical or manual side as well as the business side of farming can be better learned by experience on a farm that is being managed for business purposes than on a college farm. The time in college is all too short for the learning of principles and for the development of the man, without giving time to those things which may be acquired more cheaply and efficiently elsewhere. I would set this high standard of education in the agricultural college, because their graduates are to be the few among many. Some of them are to be leaders and teachers, and therefore their training should be broad and thorough. They should not be false lights, and as men they should be known as types of cultured manhood.

But, during the severe study and discipline of four years, along the lines which we accept as essential to the proper education of the man and to his training in matters of sci-

ence, what has been transpiring with the student? He has been developing rapidly all this time. His training has had an effect upon his intellectual status not unlike that which was the result of the time-honored classical course. New views have opened before him, new ambitions have been aroused, he has become conscious of enlarged powers, and he goes forth from college halls determined to be and to do. The whole man has been quickened by new impulses. His standards of thought and his measurement of success have been changed. The young graduate, as he steps into the world, pauses to survey the field before him. He feels the spur of his acquired mastery over matter and thought. As he looks out upon human society, he observes that some have risen above their fellows in reputation, in power or in the money recompense which they are receiving for the use of their time, and he is almost irresistibly called to follow in the footsteps of those who have attained such apparent success. He has no capital, perhaps, and so can he be blamed if he consents to sell his time to the highest bidder? What would you do if in his place? He is poor and has all the aspirations of the best New England manhood, and he longs to find himself in the midst of great opportunities for development. Shall he go back to the farm as a hired servant? What would you do if in his place? If he has broad acres of his own or may acquire them, and loves the farm, if he can see the great possible usefulness that lies before him as an apostle of enlightened agriculture and the high standard of living that he may attain with the peace and beauty and inspiration of nature all around him, then he should return to his farm, and we give him our hearty welcome. No more useful citizen can be found than he may become, and his measure of recompense and satisfaction will be all the larger because of his college training.

I ask you to remember, however, that every young man is compelled to consider the relation which necessarily exists between preparation and opportunity. We cannot avoid this inquiry, To what extent do the opportunities in practical agriculture which are open to farmers' sons justify a college preparation? Perhaps, with the ideal rather than with the actual in view, you will at once say that any man who pro-

poses to be a farmer can afford to spend four years in college.

But travel with me in imagination one hundred miles over these New England hills, survey the farms, large and small, smooth and rough, near the markets and remote from markets, with desirable social environment and isolated from social life, and tell me, not on the basis of what might be if millennial conditions prevailed, but on the basis of what a trained business judgment would accept, the proportion of those farms you could conscientiously recommend as offering attractive business inducements to young men which should cause them to spend four years and several hundred dollars in preparation for the very limited opportunities which attend some of those remote and unpromising fields. It is certainly Utopian to expect a much larger proportion of college-educated men among farmers than in any other important industrial class. I doubt if well-informed agriculturists, in passing judgment upon other classes, are prepared to assert that the mechanics in our workshops, where intelligent, skilful labor, accompanied by more or less knowledge of principles, is demanded, should generally be college graduates. They would not claim this of the commercial world. It is self-evident that some mechanics and business men should be, or even must be, highly trained, but it would be foolish to expect this of more than a small minority. What farmers are not justified in claiming for these others, they may not reasonably expect in their own ranks. Every calling has its gradations of opportunity, with corresponding gradations of encouragement for the investment of intellectual capital. No business will ever be an exception to this rule. There are many openings in agriculture, — and these are on the increase — that offer encouraging recompense to the man who has taken his baccalaureate degree; but on the farm, as everywhere else, the law of supply and demand is in force.

Now, my friends, remember these things when you are tempted to criticise agricultural colleges because more graduates are not farmers. Do not forget that conditions more powerful than any influences which college halls may exert are determining the life work of your sons and daughters.

This is a young nation which is passing through a period of intense development. There is a call on every hand to new conquests in the industrial arts which are utilizing our vast material resources; large financial prizes are open to the indomitable energy and pluck of the Yankee; the professional and legislative fields are fertile with opportunities to render distinguished service in solving our unique social and political problems. Nowhere on this continent is the thrill of these great possibilities felt more keenly than in these New England States. You have become a manufacturing people, to whose shops and mills are gathered the raw materials of all nations. Here is the nurture ground for much of the professional ability, the scholarship, the literature and the statesmanship of this great republic, whose triumphs are every day opening up new possibilities to its young citizens.

Cast aside, then, I pray you, that sentimentalism concerning farm life which is devoid of business sense, and without the hindrance of prejudice allow your judgment to deal fairly with the youth who, in the midst of the largest opportunities that were ever presented to ambitious manhood in any age or among any people, is an anxious seeker for all the rightful acquisitions and honors which he may wrest from the life before him. Without criticism, allow him a free choice of his calling. Be content if some of your sons see in agriculture the fulfilment of their highest aspirations, and give to the others the Godspeed that you do to those who enter into the work you hold so dear. And, above all, do not expect those considerations which everywhere prevail regarding the returns from an investment of capital, intellectual or otherwise, to be ignored in the affairs of agriculture.

Do not understand me as claiming that the agricultural colleges of New England have been utilized to the full limit that wisdom and good judgment would dictate. There are scores of farmers in all these States, and many who have declined to be farmers, the great mistake of whose lives is that they did not spend a portion of their youth in securing the best possible preparation for a life work on the farm. They have been content either to leave good agricultural

opportunities for a narrower field elsewhere, or they have been satisfied to start in the business of tilling the soil with a limited understanding of the natural world, when they should have had a broad knowledge of the laws and forces of matter and of life. For many young men a four years' course at the agricultural college is the most profitable investment of time and money they could make, and some who have failed to see this are now confessing their mistake. Moreover, there are yet unfilled, highly useful, honorable and fairly remunerative opportunities in the field of agricultural education and research. Agricultural colleges may not be able to directly instruct the mass of farmers, but they are fitting men to teach and investigate in matters pertaining to the farmer's art, and here we find, I believe, their peculiar mission as educational institutions.

I trust that what has so far been presented has not seemed to you to be unsympathetic or harsh. I should greatly regret saying anything that would depress the spirit of faith and courage with which we are pressing on to better things in the world's sustaining industry. My only purpose so far has been to display, frankly and judiciously, the reasons, as I see them, which have caused disappointment all along the line in the number of young men who in New England have been moved to give extended study to the principles of agriculture. Let us now turn our attention from an analysis of the reasons that have affected the attendance upon the agricultural colleges to a discussion of the mission of these institutions, a mission the nature and value of which is clearly seen in the light of thirty years' experience.

The considerations already presented to you make it clearly evident that the great bulk of the agricultural population will not in the future any more than in the past come up to the agricultural college for an education. Not even the short winter courses provided at some institutions, and which are generously attended in a few States, will secure a general systematic instruction in the fundamentals of science as related to the farm. These short courses are doing a grand work, but they fall far short of compassing the whole field. We must from now on, if we have not done so before, face the problem of providing in the public schools or in wide-

spread special schools the education in the natural sciences which seems to be so essential to those who practise the art of agriculture. Just how we shall accomplish this does not yet appear. But, whatever plan may be adopted, there is no avoiding the conclusion that at the head of this educational effort will stand the agricultural college for the training of experts, teachers and leaders, and for the direction of plans and methods. This, then, I believe to be the mission of agricultural colleges. How shall this mission be executed?

Primarily it is the function of the agricultural college (I mean by the agricultural college either the separate institution or the agricultural department of the land-grant college) to give to young men, and to young women also if they want it, thorough and extended instruction in the relation of the sciences to agriculture. It is incumbent upon the college, also, in so far as available means will permit, to apply to this instruction the best apparatus, the highest talent and the latest knowledge. Moreover, the course in agriculture should in no sense be subject to the charge that it evades its specific purpose. While, as I have tried to show, it should aim to give to a student a liberal education, a fair share of it should be technical, and the subject matter, together with the means of illustration, should be directly important to agriculture as an art. The relations of existing knowledge to tillage, fertility and animal nutrition should not be covered out of sight in a so-called general training course, no matter how favorably the latter may appeal to the pedagogue. Any student who is really anxious to learn what we have come to speak of as agricultural science should not be allowed to turn away in disappointment. Such a course of study, efficiently maintained, is abundantly justified by the demand for it and the profound influence it is bound to exert upon the life of the people through the education along special lines of even a comparatively limited number of graduates.

It is asserted, occasionally, that the agricultural colleges are unnecessary institutions; that the instruction which they are giving is not so essentially unlike that of the scientific departments of other colleges as to justify the added expense which they entail. This feeling was roughly expressed by a New England paper not long since in a statement that cer-

tain New England denominational colleges were "just about as much farmers' colleges" as a particular land-grant college which was mentioned. Such assertions are made in ignorance. Many educated persons have little conception of the real and essential difference between a course in applied science and such courses in the sciences as are occasionally offered in the old-time institutions. They do not understand how much nearer the agricultural course touches the conditions and needs of human life and activities than does one in which the mere abstractions of chemistry and biology are presented.

I venture to affirm, that only through the establishment of agricultural colleges has such a course of study as I have outlined above become possible. The traditional standards prevailing in the classical institutions of the country at the time the State colleges were founded were an effectual obstacle to their teaching the relations of science to the arts in a proper and adequate manner. Some of the older colleges have not even yet become reconciled to this new departure in the matter and manner of a higher education, and they still have lingering doubts whether God's living, pulsating universe is so worthy an object of investigation and study as the language and literature of departed peoples. To be sure, scientific courses of a high order are now established in some of the classical institutions; but nowhere outside of the agricultural college will you find certain facts of science presented to the student in the sequence and manner which constitute the genius and specific value of the agricultural college class room. These new institutions which we are discussing were the inevitable outcome of any well-considered successful attempt to organize for teaching purposes the knowledge of science in its relations to the farmer's calling. They have their necessary place in the material progress of this scientific age, as experience has proven.

The boards of control of the land-grant colleges have been intrusted not only with a special educational effort in the interests of agriculture but also with the investigation of problems important to agriculture. The experiment stations are in most cases departments of the State colleges, and very properly so, for they are a logical result of college influence.

They were made possible through the efforts of agricultural college men, and their staffs have been selected almost wholly from the graduates of the institutions into whose care they are committed. It is safe to say that, without the Morrill act of 1862, the Hatch act of 1887 would even now be a remote possibility. It has become, therefore, the mission of the agricultural colleges to guard and cherish this effort of investigation as carefully and as loyally as they have the departments of instruction.

But what should this investigation be? In other words, what is the function—the mission, if you please—of the agricultural experiment station? I ask these questions because, in my judgment, the true work of the experiment station is not properly understood by the agricultural public. It is even possible that here and there a board of trustees has misconceived the real intent and requirements of the Hatch act.

There is a tendency to ignore the essential difference between instruction in things known and the discovery of things unknown, between teaching and investigation. The function of the experiment station is to investigate. It is not a pedagogical institution, nor is its primary work to give popular instruction from the institute platform. It is necessary for the station worker to keep in touch with the pedagogue and with public opinion and needs; but his chief business should be to continuously and severely study the unsolved problems in chemistry, physics and biology, whose solution is essential to progress in agricultural practice. Now, there will rarely be combined in one man the successful pedagogue, investigator and institute speaker. The limitations of time and strength, to say nothing of the special fitness and preparation for each line of work, preclude the possibility of the highest success in any direction when thought and energy are so divided.

At the convention of college and station men held in Minneapolis in the summer of 1897, as chairman of the section of agriculture and chemistry I pointed out the fact that on the basis of returns from thirty-four stations less than one man in each station is devoting himself wholly to station work; that theoretically half the time of those who

are both teachers and station workers is given to teaching; that an average of sixty-four public addresses was given yearly by the staff of each station; and, in general, that the effort of investigation is being to some extent, at least, buried in the effort of instruction. The comments upon this report by the U. S. Office of Experiment Stations in a subsequent number of the Experiment Station Record were to my mind so able and convincing that I desire to present them to you.

Certainly the Hatch act makes it very plain that the prime business of the stations is to investigate. Now, the investigator may easily add to his primary functions those of a secondary character, and act as a teacher, lecturer or ready-reference-information monger. The real question is, how far can he go in this secondary business without injuring his ability and success as an investigator? After careful inquiry and personal examination of the conditions existing at our stations, we are prepared to answer this question so far at least as to affirm without fear of successful contradiction that the investigator cannot act so much as teacher, lecturer and information monger as he is actually doing at many of our stations, without seriously impairing his usefulness as an investigator. Four or five hours a week in the class room or laboratory with advanced students may be a most inspiring thing for a station investigator, but it is a far different matter when he must follow the routine of more or less elementary instruction in some general science twelve or fifteen hours a week. In the latter case he will be a rare man indeed who is not so wearied by his duties as a teacher that he will not be able to do his best work as an investigator. He may accomplish considerable useful work for the station, but it will probably be of comparatively low grade. A half dozen lectures and quizzes at farmers' institutes in a season may correct the theories of investigators, and reveal to them in a new light the real problems of the farmers; but a three months' campaign in the lecture field is most likely to seriously diminish the stock of energy which is necessary to solve these problems by experimental inquiry, and seriously interferes with planning and work. An occasional letter or leaflet on some familiar topic, to satisfy the earnest desire of the farmer correspondent for live information, may refresh our investigator's mental powers, but the dull grind of a voluminous correspondence or popular composition will most surely sap his alertness in the pursuit of new truth.

There is no suggestion of an abuse of funds in the New England experiment stations which is the occasion of these remarks. If such were the case, my utterances might be taken as discourteous, or even an impertinent interjection of my opinions into a field in which I am not directly interested. My only purpose is to aid, if possible, those who bear the responsibility of giving wise direction to the use of the several funds devoted by the general government.

Do you as farmers demand popular instruction from the institute platform? It is unwise to ask much of this from the already overworked teacher. Must you have teachers in your college? Then make it possible for them to gather up and assimilate an ever-increasing supply of available knowledge. Must you have investigators? Then give them time to study and to think. A prominent director once said to me concerning a member of his staff, — “Professor —— has his periods of seeming inaction, when he sits in his laboratory apparently doing nothing. I am entirely satisfied to have him so spending his time. He is *incubating*.” The results which this professor has given to agricultural practice justify the wisdom of the distinguished director’s policy. Find no fault, then, when station men retire to their closets for study and meditation. Give them time to do this, and be sure that when they emerge they will bring to you beneficent interpretations of nature. If you, as citizens of this State, as Massachusetts farmers, are asking for all these lines of effort in your behalf, then listen when the officers of your college and station tell you of the conditions necessary for their work, for they are earnest, conscientious men. This State is big enough and rich enough and its agriculture is important enough to warrant generous support to the institute speaker, the teacher and the investigator, each working in his own way, untrammelled by other duties.

Viewed in the light of experience, what may we expect as the direct results of this teaching and investigating? The answer is plain, and we need not seek for it with hesitancy or fear of disappointment. Notwithstanding the fact that the graduates in agriculture are greatly less than those in engineering or in the more general lines of study, the consequences following in the train of this educational effort have

been of the highest value. It has been well worth while for the State of Massachusetts to establish and maintain its agricultural college, not only for the sake of the influences this institution has exerted at home, but also for the sake of the contributions which it has made to enlightenment in other States by sending well-trained, earnest workers to become teachers and investigators in their colleges and experiment stations.

Consider the local benefits. What a vast amount of scientific, well-organized, useful facts and principles have been assimilated by New England agriculture during the past twenty-five years. How has this been accomplished? What have been the avenues along which this knowledge has reached the mass of farmers? You know the answer, — imitation of good example, contact of man with man and instruction from the platform and through the press. But what has been the centre of agitation, the immediate source of this information which has radiated to every hamlet and farm of your State? Your college here at Amherst. This institution has been the local interpreter of the lessons of modern science, the vital connection between you as farmers and that world-wide application of nature's laws and methods which is now upon us. It has sent out men who have become centres of local influence; its faculty and graduates have stood on farmers' institute platforms and have freely contributed to the literature of advanced agriculture. The publications of your experiment stations have been the feeding ground of the agricultural press; and the opinions and researches of the experts congregated here have been widely quoted as authority in the difficult matters of farm practice.

As I have tried to show, the direct instruction of the great masses of farmers in the college class room is not likely to be realized. In the world at large existing conceptions of truth in science, government and religion have filtered to the people through conversation, reading and public discussion. So have the modern views of farm practice as seen in the light of science been spread abroad, and back of this propaganda of a new gospel for the farmer have stood and will continue to stand the agricultural colleges as organizing and

directing forces. The critics who think only of the number of graduates, and take no account of this important and wide-spread influence of these educational centres, entertain a very narrow view of the work of such institutions. The graduates may have been comparatively few, but they have been of the tribe of Levi. They and their teachers have been high priests in the temple of agriculture, and with their faces turned to the light emanating from a wonderful revelation of nature's laws and methods, they have ministered to the people according to the measure of their understanding.

As a preface to the conclusion of this address, I desire to quote to you a brief portion of the act of Congress of 1862, which donated public land for the maintenance of the so-called land-grant colleges. Section 4 of this act declares that the leading object of these colleges "shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the Legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

It is unnecessary, perhaps, to remind you that the agricultural class includes more than the farmer himself, — it embraces the farmer's wife, the farmer's son, and last, but in no sense least, the farmer's daughter. By this I mean to declare that not only the art of agriculture, but the home with its environment and the proper nurture and training of the children to take their place as workers, as husbands and fathers, as wives and mothers, are involved in the spirit and purpose of the first Morrill law. This act of Congress has a most comprehensive relation to the life of the people. The laws of chemistry and physics that the farmer must consider should be recognized by his wife. The principles that pertain to the feeding of colts and calves are identical with those that are related to the feeding of children. The outlook in literature, philosophy and economics that are so important to the man, are equally important to the woman, who, as a mother, is so potently determining the status of our citizenship.

Do I mean to say that the agricultural college should offer to young women, as a means of fitting themselves for the practical duties of life, all the advantages that it does to young men? I do, most emphatically. Human society is not unsymmetrical with a preponderance of influence and duty on one side of the sexual line. The sexual line marks a partial differentiation of work and responsibility in kind, with but little distinction as to importance. I am profoundly convinced, then, that it is the mission of agricultural colleges to promote home economics as faithfully as they do farm economics. No other institutions are called upon to maintain so close a relation to the physical and economic life of our people as do these. The scientific truths that touch the farm touch human existence and activity at all points. One art, one sex, one condition, one class of society, cannot move along by itself in an independent progress, and any symmetrical, well-considered scheme of education must recognize this fact.

It is the industrial classes whose liberal and practical education is to be promoted. What a vast responsibility such a scheme of education entails! These classes are the seed bed of the nation's character. Here we sow knowledge, interpretation of truth, sentiment and moral purpose in a fertile and responsive soil, each to spring up and grow and fruit after its kind. Here and there some towering growth in industrial effort, in literature, in statesmanship or even in the art of war shall encourage and inspire us; but we shall accomplish our chief and highest purpose if the life currents of the people who attain no high altitude of intellectual or social distinction shall build into the body of our nation the enduring and invincible fibre of truth, justice and patriotism. Upon you, citizens of this mother State, has been laid the duty and high privilege of ministering in no common degree to the nourishment and manner of growth of this dominant republic. May this heritage pass from generation to generation as a solemn and cherished trust!

The CHAIRMAN. This lecture this afternoon must have opened to you new avenues of thought, which I hope some of you will feel like following out. The distinction which

was drawn between investigation and instruction is one which I think was exceedingly pertinent, but the two must go hand in hand. We investigate in order that we may teach the better, and we teach in order that we may know what and how to investigate. They go together, and the double cord is not easily broken.

The address is now before you, and we shall be glad to have any one speak. One of our old instructors, one of our pioneers in agricultural education, is here to-day, and we hope we shall hear from Professor Stockbridge.

Prof. LEVI STOCKBRIDGE (of Amherst). I have listened with delight and with instruction to these nuggets of truth from the lecturer. I feel that I can indorse almost every word that has been uttered, and I hope you young people will learn wisdom from what has been said. I had not the remotest idea that I was to have any part in these exercises; I did not know that I was spotted for anything until a suspicion went over me when I walked up this aisle this afternoon. You may be perfectly satisfied that I am not so egotistical as to think I can add anything to what has been said.

This address, as I understand it, was on the mission of the agricultural colleges. How simply it has been answered! Thank the Lord that the lecturer has answered it so that no man can improve upon it. He answered it when he read a portion of the law of 1862. That is one of the nuggets I am speaking of. What is the object? It is to give to the farmers and mechanics of this country the same training and the same culture and the same fitting for all the duties of American citizenship as is given to the lawyer, to the doctor or to the clergyman. It was the object of the act to give to the farmers of this country the same culture, the same power of thought in their line of duty as is given to the others. Is not that simple? You cannot make it any more poignant than that. I found the lecturer was making a complaint because our agricultural colleges were not full of agricultural students who, after completing their education, return to the farm. My way of looking at it is, — and I went through this mill and was ground out a great many years ago, — that other educated classes have the power and influence in the community. My opinion about this matter is that the primary

bottom cause goes about as far back as total depravity. The sentiment is all through the community, — it was when I was a youngster, and I do not know as it has improved, — that any very very bright boy who enters the common school must go to college and be a minister. This opinion has pervaded the whole community for generations. It begins in the kindergarten, and goes to the common school and to the high school and finally to the college. I greatly fear, — I hope I do not know it, — that that same instruction which was started in the kindergarten and went through to the common school and to the high school has found its way into the teachers of the agricultural colleges. I fear that you have in your agricultural colleges teachers who have the same influence to-day. That is what is the matter with many of your boys who graduate from the agricultural colleges and go somewhere beside to the farm to do their life work. What does the act of Congress say? I would have no teacher in an agricultural college who should not be saturated through and through with what is found in the last clause of that act. He should take these boys and fill them with all the science he knows, directly in the line of agriculture and mechanic arts. He should cultivate them to be bigger and more useful citizens and fit them for all the duties of citizenship. That would be fulfilling his mission.

The CHAIRMAN. We would like to hear from some of the teachers.

Dr. C. S. WALKER. There are two or three thoughts that have occurred to me. I think the lecturer of the afternoon is a graduate of an agricultural college. Now, I think there we have one great encouragement. We have sent out from our agricultural colleges men like the lecturer of the afternoon. People have heard him and seen him, and have asked what college he came from. The reply is, “an agricultural college,” and the people say, “I guess I had better send my boy there.” One of the best arguments which our agricultural colleges set forth is the character of the men who go out from the institutions. Now, I think that if a few men of this stamp go out over the length and the breadth of the land, they will furnish arguments for the colleges which will maintain them.

Another thought occurs to me, and that is, that these agricultural colleges are established by the statute of the United States and under the auspices of the several States. Now, then, what flesh and blood are to the individual man, that the soil of the nation is to the life and power and influence of the nation. England, with a little bit of a soil, has been able to maintain itself; but it has outgrown the soil, and it is dependent for its bread and butter, for its elements of subsistence, upon other lands across the sea, and it would have perished long ago had it not been for this nation. We have here in the United States a great nation only in its infancy. Presently it will be doubled in population. It has already doubled its population within the lifetime of many of you here—from thirty millions to seventy millions. In a few years more there will be one hundred and fifty millions, and probably before a century more three hundred millions. Now, then, how shall the nation take care of its soil? We have exhausted our wheat fields. We have exhausted many of the elements of the soil. Shall the soil of the United States be exhausted, as the soil of Palestine, as the soil of many European countries? It will be, unless the people are taught how to use the soil without destroying it. A manufacturer takes certain elements and consumes them in the manufacture of his goods. There must be a raw material, and that raw material must come out of the soil. Agriculture has the power of feeding a nation, and yet without destroying the earth out of which the food must come. I think we are very wise in all of these many States to establish experiment stations and agricultural colleges, to find out in the first place how to use this broad land of ours without ruining it, and how to train the people to use and improve the land.

One other idea. In the old countries of the world the king who is to rule is given the very best education. Private tutors are supplied for him, all the wisdom of the world is brought, so that he may have the very best education. Thus the kings of England have been trained. Who is king in America? The agricultural class. The men of the agricultural class are the ones who have the power; they are the ones who are to rule in this great land of ours. Shall they

be educated, or shall they not be educated? The States, looking into the years to come, say, if democracy is to maintain itself long in these United States, these people must be educated. As to the method of education, how shall they be educated? Can they be educated by taking a dead language and putting themselves back of the time of two thousand years ago? That is perfectly impossible. What must they understand? First, the earth on which they stand, and then the forces by which they are surrounded. Let a man understand the earth and the powers of the heavens, let him master the soil and the lightning, let him master the secrets of life, and that man is educated, though he may not be able to read Sanscrit, Hebrew or Greek. We have had a trial of about thirty years of this method, and we are producing men who can hold their own against any classical institution. We are giving such a good training to the men who go out of our colleges that the ministers, the lawyers and the doctors all want to send their sons to our colleges; but the word "agriculture" is not tony enough. They say, "Rub out the word agriculture, and then we will send all of our boys to the college." Now, we do not want to do that, but we can make the training so thoroughly practical that the time will come when it will be fashionable to send students to the agricultural college rather than to the others. The classical colleges were originated in the first place to train ministers, and were supported by contributions from the churches. A charitable contribution in the course of a century cannot establish that which the State can secure. So we find in the west and here in the east that the State institutions are establishing themselves, and they are educating the citizens.

Our college is only thirty years old. Wait until it is a hundred or two hundred years old, backed up by the support of the contributions of the State and of the United States, then you will see a magnificent future before us. Therefore I think we should not always confine ourselves to the individual point of view of the farmer's boy who is in the college to-day, but to the generations which are to come. We are laying the foundations here not for the closing years of this century, but for all of the coming centuries which are before us. The plan is right, the opportunity is ripe, and I am perfectly as-

sured that we shall meet with a glorious success. We should be inspired rather than to be at all disappointed.

Prof. G. F. MILLS. It is of very little consequence to you to know what I did as a boy and as a young man. But, that you may know that I have reason for sympathy with agriculture and agricultural education, I wish to say that I know what it is to hold a plough. I have been in the hay field before the day of mowing machines, when we had to swing the scythe. The son of a farmer and the grandson of a farmer, I feel that I have a right to say something to those who to-day are interested in agriculture. I think every one here must feel grateful to the lecturer of the afternoon, who has suggested so many valuable lines of thought and who has shown us so clearly the mission of the agricultural colleges. I say education is a broad subject. It is not easy for us to compass it in a short time. I am not disposed to discuss methods of education, or even to say much about the particular subjects of education. I must say, gentlemen, that I think we make a great mistake when we decry the work and the influence of these broad-minded, profound thinkers and scholars, who have passed the torch of learning from its home where it was lighted, passed it on to the western nations, who in their turn passed it over to the island which was the home of our own people, who also passed it across the great ocean to us, and when it was brought to the Atlantic coast it could not be held there, but was passed again to the west, across the Mississippi, across the prairie to the Pacific coast, and so on until it should complete the circle of the earth. I say that we make a great mistake, it seems to me, when by our public addresses we attempt to cast any discredit upon the work of such men. Their work has broadened education, developed it, prepared the ground to make it possible for the day to dawn when the agricultural colleges and the colleges of scientific investigation and instruction should be demanded in the interests of the people.

A writer in speaking of New England spoke of "the anæmic towns that are dying for the want of blood," and I think some of us may know that that is a correct characterization of a great many New England towns. It is the mis-

sion of the agricultural colleges to infuse learning into these lifeless towns. It may not be in a particular way, it may not always be in a definite specific line, — but here is a young man who has been in an agricultural college, he has a taste for investigation, his surroundings take him back to his own home; but his eyes have been opened, his intellectual horizon has been broadened, and he goes back to the old town to be a new light and power there. I was glad when the lecturer of the afternoon referred to the fact that the student of the agricultural college will find a work; a preparation in him is being made to make a New England home sweeter and more beautiful, to make the influence of the New England citizen stronger and more helpful, and to do for New England and the States of New England that which could not be done were it not for the agricultural college. I plead, ladies and gentlemen, for the interests of a broad culture. I believe in developing, so far as possible, the entire man. I would not keep him in one narrow way. I believe a young man should know something about everything and everything about something; and it is this work that it seems to me the agricultural colleges are doing, — broadening the minds of the students and preparing them to do useful work, and, if they are called to go back to their New England homes, preparing them for useful work there in the community in which they may live and to be a blessing to their day and generation.

Now, as I said, I do not think it is wise for us to decry those who may not be working in the same lines in which we are working. Other forms of education and instruction have given us men of whom we are proud. One of these is the president of the Massachusetts Agricultural College, and some of them are found in similar places in other institutions. We are glad of them, are we not? If the ambition of any young man in an agricultural college is stimulated to take a wider field and to prepare for a broader influence than that which he had in view when he entered the institution, I for one say God be praised, and may the light kindled in that heart and soul be so bright that it shall kindle a light in many other hearts and souls.

The CHAIRMAN. Dr. Jordan would like just a moment.

Dr. JORDAN. I want to talk to you just a moment off my elbows and not off paper. I am glad to hear these comments. Professor Stockbridge was teaching these things when I was a boy at college. I am going to shake hands with him at the close of the meeting.

Professor STOCKBRIDGE. Come now.

After shaking hands with Professor Stockbridge, Professor Jordan said: That does me good. Now, the value of the agricultural college is not measured by dollars and cents. The first thing on the farm is the man, the spirit in the man. We are not in the grip of conditions, we grip conditions. In some communities men get in a despondent condition when they think hard times are around them. But you take a community of people who have absolute faith in their ability to control themselves and their business and the conditions around them, and they will do it. We depend on legislation altogether too much for the control of conditions we have in our own grip. In the State of New York we have a tremendous institute system. My friends who are managing these institutes to a large extent are men from Cornell and from Geneva Experiment Station, who are with only one exception either graduates from the farm or agricultural departments of our colleges. I have in the Geneva Experiment Station ten men from the State of Michigan, five residents of that State, and most of them are graduates of the Michigan Agricultural College. I have not been able to get any from Amherst, because they are all snapped up to go elsewhere. In these institutes the people are giving attention not only to the business side of agriculture but to certain discussions of domestic economy, and all these things that have a tendency to uplift the people.

Dr. LINDSEY. After listening for an hour or more to the extremely interesting address and to the discussion, I feel very much like putting on my coat and going home to my closet and sitting down and thinking. I feel that it would be unwise almost for me to be vulgar enough to stay here and attempt to touch, as it were, anything that the speaker has said. It seems that he has treated his subject so thoroughly that it would be unwise for me in any way to

touch it. And yet I have just a thought or two that I wish to bring to your minds. First, I want to endorse what a previous speaker has said relative to a mistake which I think some of us are liable to make with reference to other colleges or institutions. This is a State with a large number of institutions, and I believe they all have their place. When I was a boy I was induced to attend our agricultural college at Amherst. I was urged by some to go to some other institution. I came here, and am not ashamed of it. I am very glad that I made up my mind to take just the course I did. It might not have been a wise course or a wise move for some one else. There are many educational institutions, and I believe they all have their place. I do not believe we want to be jealous of them at all. If my brother wants to study Latin or Greek, I say to him "Go do it." One thing that interests me is the future mission of the agricultural college. I have thought a great deal about it, and it is not quite clear in my mind yet, — not as clear as I could wish it to be. Thirty-one years ago we did not have any agricultural college, and we did not know exactly how to go to work. We had comparatively few men in our country who had any experience in these lines of work. We had to try and do the best we could. Is it any wonder that we have made some blunders? Is it any wonder that we are still far from perfection? I believe we have done a good work, and I believe the light is dawning and we can see more clearly than ever before the future line in which we ought to work. The problem has come to Dr. Jordan and to many of us, Why do we not receive a larger number of students who desire to study agriculture? Why is it that many of the students who come to us do not follow agriculture in some way or other after they complete their course? Every young man when he gets through with his college education finds himself confronted with this condition of things: Here I am twenty-two years old, perhaps, I have been fortunate enough to secure four years of training, now I must look out for myself. What am I going to do? How can I best look out for myself? How can I make the most of myself? Most of the students who go to the agricultural college are handicapped from the

financial stand-point. Many of them work hard during their college life, and get through with hardly fifty dollars to their name and possibly several hundred dollars in debt. The question that comes to them is, What am I to do? Some of them have an opportunity to go back to the farm and work out their salvation there, and they do it. We have many notable illustrations of what young men can do in making a success of agriculture. Others have no farm to go to and they have no capital at their disposal; and you, my friend, would not advise these young men as a rule to attempt to pay their debts and get a little money ahead by going on to a farm. Agriculture involves capital, and without capital it is a pretty rough row to hoe. If they have no means, they must do whatever they can. Many have said if they only had the money they would gladly go back to the farm. It seems to me that we ought to look at this in the right spirit, and attempt to get a clear understanding of the matter. I believe in agricultural education. I do not believe that we are going to get a large number of men from the farms of Massachusetts who are going to our agricultural college and go back to the farm, because of the financial conditions and because there are so many other opportunities that present themselves; and yet I believe that there are young men who will go back on to the farms, if they have courage, and make a success of it.

A man said to me a little while ago: "I would pay five cents a quart for milk willingly if I could get the right kind of milk. I cannot get hold of it." I asked him what he wanted. He said, "I want milk that comes from animals that are well taken care of, from animals that are kept clean; I want milk that has no odor to it, that I can put into bottles and put on the market for eight cents a quart. I find a great deal of difficulty in getting it." There are opportunities for men to-day to do something along the lines of agriculture, if they would only be equal to the occasion. We are specializing more and more. We are talking more about poultry raising and more about dairying than we ever have done before, and I believe the men who have the opportunity to go to our college and prepare themselves for this line of work will make a success of the work. But I do not believe that we are

going to be overrun with students who come from the farm and who are going back to the farm. I do believe we are going to have a certain number of men who will come to the college and go back to the farm and make a success of it. It depends to a great extent on the man. Do not judge every man by too high a standard.

Adjourned.

EVENING SESSION.

An evening session was held at 7.30 o'clock. The lecture was by President G. Stanley Hall of Clark University. Subject, "The love and study of nature (a part of education)." Owing to an unavoidable delay, the lecture is not printed here, but will be found later, in the proceedings of the winter meeting.

SECOND DAY.

The meeting was called together at 10.30 A.M. by Secretary SESSIONS, who said: The hour has arrived at which we should begin our proceedings. If the speaker says anything you do not believe, we want you to hit back, and we want all the time there is. The suggestion has been made that if any of you intend to "lock horns" with the speaker you had better come up front, where we can all get the benefit of it. The vice-presidents and the executive committee have decided upon Mr. AUGUSTUS PRATT of North Middleborough as the presiding officer for the forenoon.

Mr. PRATT. Ladies and gentlemen: I wish to congratulate you on the beautiful morning of our meeting. We have had a very pleasant and entertaining visit to the well-managed agricultural college of our State. We have seen the well-arranged buildings, the beautiful grounds of our agricultural college; and it seems to me very appropriate that this morning, after our visit, we should take up the subject before us, which is, "The business side of agriculture." We are fortunate to-day to have with us a distinguished gentleman whom we have listened to many of us many times with great profit; a gentleman who has pursued the business of agriculture in his own State until he has outgrown it and has gone to the south to cultivate a more extensive area. It is with great pleasure that we have the privilege of hearing to-day—I say it because I believe it is the truth—the greatest peach grower in the United States. I take pleasure this morning in presenting to you Mr. J. H. HALE of South Glastonbury, Conn.

THE BUSINESS SIDE OF AGRICULTURE.

BY J. H. HALE, SOUTH GLASTONBURY, CONN.

Mr. Chairman, ladies and gentlemen, and brother farmers : I thought yesterday afternoon, when I listened to the eloquent and able address of our friend from New York, and finally to the words of wisdom from our old friend Stockbridge, that it was hardly right and proper for me to come here at this seat of agricultural wisdom of Massachusetts and try to say anything to benefit agriculture. When my friend Stockbridge was speaking, my mind quickly went back to one of the very first meetings of the Connecticut State Board of Agriculture. Our good friend was there, and talked about things that were Greek to me. I suppose it was the first I had heard relative to phosphoric acid, potash and nitrogen, and I got it mixed up with a drug shop, for it seemed to me it had nothing to do with my work as a farmer. But that meeting, and other meetings where men of like calling and like faith in agriculture have spoken, have stimulated me to whatever of success I have met with in agriculture. I wanted to say yesterday, when our friends were belittling the work of the colleges, — I think Professor Jordan did, a little bit, — the tremendous work they are doing outside of their legitimate calling, that their indirect work would always be their greatest work.

My subject is “The business side of agriculture,” and I know more about that than I do about agricultural education, because I did not have any agricultural education. What little I know I have stolen from others or dug out of the soil.

Perhaps we sometimes get an impression of business as I did the other day. I ran across a man who was whitewashing some buildings. He had bought some brushes and was daubing the whitewash on with the brushes. I suggested

that he get a spraying machine and rig that up and spray the buildings. As soon as he got the spraying machine at work he said, "That is business." His idea of business was doing something in a quicker, better and more economical way. We know that some people can take a piece of paper and make a few marks and have a beautiful sketch. That is art. If Vanderbilt should take a piece of paper and write on it, "Pay fifty million dollars to the gypsy moth committee," you would all say "That is business." I may get you mixed on these definitions, as I am myself. I was in Maryland last week, and when I bought my ticket a young gentleman also bought one. He evidently gave a large bill in payment for it, and after he had taken the change he turned and walked away, leaving the ticket. A friend took the ticket to him and said, "I rather think you are absent-minded; you must be in love." The young man said, "No, I'm not in love; I'm married." You younger people will not know what that means, but the older ones will. So we may at times all get a little mixed on definitions.

The strict definition of the term "business" is a mercantile transaction. That is what we need in agriculture. We need to use our brains, and use them from the business standpoint, as all business men have to do to succeed. I have said before that from force of circumstances the farmer is a capitalist, is a laborer and is a business man all combined in one. The farmer too often forgets that he is anything but a laborer. The farmer as a rule has been working too hard and thinking too little. Some of you will think of your neighbors, and say that they have not been working too hard, that you think they would do better if they worked a little harder. A good German friend once said to me, "I like you pretty well; I think you have a good farm, but, if you will excuse an old man for suggesting, I would like to say that I think you would do better if you stayed at home a little more." His idea was to stay at home and work, and he has made considerable success; but I have made more on the farm in ten years than he has in twenty, and have had a heap more of fun.

It is the business of the farmer to work and to think. He can get more for mind than for muscle. The cheapest labor

is muscular labor. Brain labor sells for the most money. I say to you young men here who are getting an education in this college that there are better opportunities for you to-day, financially, in Massachusetts agriculture than in any other business in Massachusetts that I know of, and I know something of your other businesses. Some one hinted that you had not much capital. You do not need much. If you have a belief and faith in agriculture, and the ability to work out that faith, there is money lying around idle for just such men. A right knowledge and handling of the soil is one of the essentials to success in the work of agriculture. A few years ago two men bought adjoining fields that were practically the same, and had at one time been part of one farm. They were upper hill-side pastures, somewhat wet and springy. Both were buying them for the same general purpose. Both were in a hurry to get all they could out of them as quickly as possible. One man got an engineer to plan a system of drainage, and went all through the moist places and put in drains to prepare his land for successful agriculture. He dug ditches and rolled in stones and made suitable drains four feet deep and four feet wide. He put in large boulders at the bottom and filled in with smaller stones. He spent a large amount of money in fitting up that land. The other man carted off a few stones, and did not put in any drains; and they each planted a crop. The extra investment in the business preparation for final success has paid many hundred per cent. One has been a marvellous success, and the other has been, not a miserable failure, but a fair average of the Massachusetts and Connecticut farmer. One field is paying big dividends, and the other may or may not be paying any. It seems to me that there was business in one instance and a lack of it in the other. It is difficult to figure on the cost of labor in agriculture. All the labor on the farm cannot be figured out at its exact cost.

A little incident was brought to my mind last night in speaking of the fruit industry outside of the State. In my fruit-packing house in Georgia we employ two hundred and twenty-five to three hundred hands in packing fruit. Fruit must be packed and in refrigerator cars just as quickly as possible. The packers begin at daylight in the morning and

are rushed all day. We noticed that toward the last part of the day they did less and less work. This we had seen for two or three years. They did not turn out the same amount of work per hour, and sometimes there was some fruit left over that ought to have been packed; I conceived the idea that to hurry these people up a little it might be well to bring in a little music. I hired four pieces of music to go into that shed every afternoon. I told them not to play anything very lively the early part of the afternoon, but to keep playing. "The last two hours give it to them; play the liveliest music you can until dark." We keep account by check of all the labor each one does, and then figure it out. There was an increase of fully thirty per cent from two o'clock until dark, and we had a good time, too. Hire music on a farm to handle a farm crop. That is business. I do not say it would work on every farm. When a man comes along looking for work, find out whether he can whistle or not. If he whistles a good deal he is likely to be a good laborer, and will turn off more work than one who does not whistle. Hire a man who never knows what time it is. There is business in this point.

One of our friends said here yesterday that Massachusetts farming is drifting into specialties. That is true, because it is the business side. It is business to specialize. Some one has said that specialists in agriculture are going to drive many of us into abandoning farming; that a few large farms will kill out the small farms. I do not believe that will be true to any great extent in New England. While I can see that there are opportunities for extensive operations in New England, as well as in other places, for special lines of agriculture, and co-operation can be practised in that line of work that will reduce cost of production and result in greater profit than when carried on by individuals, I believe there is a great opportunity for co-operation in agricultural work in New England along special lines. The small general farmer will always work individually, but there is plenty of opportunity for a man to be a specialist. A man who has a love for any special animal or crop or in any special line of agriculture has an opportunity to enjoy himself and to maintain a good position in a special line of

work, even though done in a small way, where he is head manager, workman, salesman and all. There are great business opportunities in small special lines, as there are great opportunities in extensive co-operative work. The manufacturers who succeed in New England — the Massachusetts manufacturers have been perhaps the most successful in the world — have been men who are specialists, whose whole time and thought and energy have been put into one special line of production. Where they have succeeded they have turned out a high class of product, a large per cent of high-grade product. If you go to the market and try to buy a high grade of goods, you find they are for sale at a price that must pay a profit on their manufacture. The damaged goods are for sale at a very low price. They sell for less than the cost of production. When there are many damaged goods turned out, what does the owner do? He begins with the foreman or with the head superintendent, and says, "Look here; there are five or eight or ten or twelve per cent of damaged goods this month. Is the trouble in the raw material, in the machines, in the labor? It must be stopped, or this mill will have to be closed." And that is what is coming to agriculture. There have been too many "damaged goods" in agriculture, too many low grades. We have been mixing them all up with number one goods and trying to sell them for number one. The manufacturer puts his number one goods on the market as number one goods. The fact that they are number one goods and sold as such guarantees that they are all right. If there proves to be any damaged goods mixed in, he has to refund the money. That is business. His business is to look out that there are no damaged goods in what are sold as first class. It is the business of the farmer to ferret out for himself the way to limit the per cent of damaged goods in his product; and from a business stand-point it is only good common sense for him to pack sound goods for sound goods, and sell damaged goods for damaged goods. That is business. We have tried to fool the public too long. Some of us have been selling anything we had, and trying to get a profit out of it. Competition is getting too sharp. The intelligence that has been brought into agriculture through

the colleges and experiment stations is stimulating a lot of bright, live, active young men who are producing a high grade of agricultural products, and the man who keeps on in the old way of producing goods of various grades has got to be left in the race in a business way.

We must learn to use good tools suitable for the work to be done and the soil we have to work on. Accept all of the new modern tools you can use with profit, but do not take up with everything because it is new. Some of the old tools are indispensable. The old hand rake and the smoothing harrow are not out of place on every farm. They should be there. For certain fields—and I have used all modern harrows—I have to go back to the old “A” harrow with long steel teeth that will cut through the turf and go over the stones in the roughest sort of a place where no modern tool would. You should get new tools and use them wherever you can use them at a profit. A man wants all the tools that can be profitably used in his business, and no more. You can reduce the cost of labor with tools, but do not forget the old tools. There is a wonderful chance for the right use of them. An ordinary old hand rake, if used in time, will hoe twice as fast as a hand hoe, and a good deal better. The smoothing harrow for many of our small crops, before they get very large, will beat the cultivator and hand hoe, is more economical and the final results are as good, if not better.

A farmer must adjust himself to the conditions of his surroundings, to the markets, etc.; and the man who can most quickly adjust himself to new conditions has a better opportunity than the man who cannot. Study constantly the methods and the market conditions, and be ready to quickly adjust yourself to new conditions, if they are better.

Thorough culture of the soil is what is needed,—more thorough culture. There is scarcely an acre of farm crops produced in Massachusetts or in the country that receives one-half the cultivation it ought; certainly, the average of the crops do not receive one-half the cultivation they ought, to give the most profitable returns. It is more profitable to harrow a field six or eight times than it is to do it only twice. You may get along by cultivating two or three times

during the summer and hand-hoeing once, but you can make more money in most cases by cultivating ten or fifteen times. Tillage helps retain moisture and free much of the plant food naturally in the soil. Deeper ploughing in many instances and a more thorough and constant stirring of the soil is what is needed everywhere. There is too much idle land in the farms of New England for the business to be successful. Every acre of land when it is not growing a commercial crop of value should be growing something to improve itself. Dr. Jenkins was talking yesterday about tobacco culture. That is not a general subject the State over. There are, however, large areas in the Connecticut valley devoted to the cultivation of tobacco. The crop is grown in two or three short months on highly fertilized lands, the crop taken off and that land left idle and bare through September, October, November and December, and an immense waste is going on. It seems to me that the farmers shrink their profits in the waste of plant food by leaving the land bare after the crop is taken off. The land should be growing some green crop, in my judgment, if for nothing more than to cover the land and hold what nitrogen is there, but still better if with nitrogen-gathering plants that will add fertility to the soil.

Farmers are buying too many fertilizers. I suppose the fertilizer men will not forgive me for saying that. I buy hundreds of tons myself every year, but we are all buying too much. Until you have saved every bit on the farm, until you have gathered in all you can gather in from outside sources, do not buy a dollar's worth of fertilizer. After you have saved everything that can be saved and turned everything into plant food that can be turned into plant food, if you still see an opportunity to use commercial fertilizer at a profit, buy liberally, but do not buy until you have guarded the other end most thoroughly. I know many who are buying fertilizer and wasting it.

I am glad to see this exhibit of leguminous crops. I grow on my Connecticut farm, by the way, from ten to twenty-five acres of these plants annually, and grow them by the hundred acres in the south. I know many acres in the south that have been growing corn continually for fifty years with scarcely any fertilizer whatever. They plant the rows four

and a half or five feet apart, and afterward cultivate it two or three times, and sow cow peas between the rows and let them grow and fill up the whole row with a solid mass of green three or four feet high and let it die down; the next spring they plant the corn where the cow peas were the previous year, and plant cow peas where the corn was. They continue in this way year after year. Probably the yield of corn would be improved by the addition of potash and phosphoric acid. But this is a tremendous lesson in economy of production, and I believe that something of the kind might be practised here with good effect on certain of our farm crops, especially if by better ploughing and more thorough tillage we aimed to free more of the mineral elements now locked up in all our soils in such abundant quantities.

I spoke a little while ago about the necessity of a more thorough culture of the soil. I got that ground into me in my early boyhood. I have been at farm work ever since I was able to work at all, and since I was eleven years old I have not attended school in summer. In those early days my brother and myself planted an old pasture with sweet corn, about two acres; when it began to come up, the land was full of witch grass. I do not know as I can give the scientific name of this grass, but you know what I am talking about. We commenced by running a cultivator lengthwise and crosswise. I rode the horse, and he was pretty bony, and I can almost feel the effects of it yet. To kill out that grass we ran the cultivator up and down and across that field every way, week in and week out. It was a terribly dry season, — a season that the farmers of central Connecticut will all remember, from the nearly total failure of all crops because there was no rain for several months. The constant cultivation kept the corn growing. In the struggle to kill that witch grass we forgot all about the corn; but the corn plant kept thinking for itself, and kept growing until early in September, and there was a good crop of well-matured ears of corn there. One neighbor said, "What are you going to do with it?" We told him we were going to feed it to the pigs. And he told us that we could sell it at a good price in the market. We took it to the market and put the price at twenty-five cents a dozen; the next

day we put it at thirty cents a dozen and the next day at thirty-five cents a dozen, and the result was that we got several hundred dollars out of that field of corn, — more money than I had ever seen in my life before, and more than I ever expected to see. But the lesson in culture I got from that crop of corn and the results coming out of it have been worth to me hundreds and thousands of dollars. Culture, culture, culture, — more of it. It will not only kill witch grass, but keep crops growing. That was a lesson to me that has been of business value. If you start in to get rid of this grass, and make up your mind you are going to do it, you do it.

We do not believe thoroughly enough in agriculture. There are a good many men teaching scientific agriculture in our agricultural colleges that have not the thorough belief in it that is needed to impress it on the boy. Even Brother Jordan feels many of the agricultural college boys may be tempted to do better somewhere else. If you make up your minds you can succeed in agriculture, you will. If you do not succeed the first season, keep it up the next. The Lord hates quitters. There has been a good deal of talk about abandoned farms in New England. Some one has been trying to explain why there are so many abandoned farms. There are no more abandoned farms than abandoned factories, yet you have not given up manufacturing. I drove fifty miles in the Connecticut valley with Professor Bailey of Cornell. We drove from Springfield, Mass., down through Longmeadow and along down through the valley to Middletown, Conn., and we found one abandoned farm and one abandoned factory and one abandoned theological seminary. Do you believe that Congregationalism is going to die out because there is an abandoned theological seminary? This seminary was located years ago way back in the country, and modern desires of modern clergymen have driven the seminaries to the town, where they could see more of “the world, the flesh and the devil,” and be better able to warn you and me against them.

I picked up a couple of farms in a county adjoining my own. They were situated on a big hill top, unsuitable for the work of the farmers who were located there. They

were trying to do a kind of farming that did not fit with the hills. The banks got hold of these farms and sold them. The farms just suited my horticultural conditions, and I bought them. I turned them into a new line of agriculture, and I think they are going to be profitable. Anyway, the assessors have run them up. It is readjustment, that is all.

A good many of you have heard about our friend George M. Clark of Higganum, Conn., and his cultivation of the hay crop. He has had wonderful crops of hay, and has been able to secure eight tons per acre on a good many acres of rough up-hill land on a Connecticut hill farm, by business methods in cultivating grass. You do not all want to go to grass. Some of you say you do not want to produce hay at the present prices; that there is no use in talking about producing hay; that the bicycles and trolley cars do not buy hay. Readjust yourselves to the conditions, and sell your hay indirectly to the fellows who ride the bicycles and trolley cars. Fifteen or twenty years ago a young farmer started in doing a general line of agriculture. I drove by his place a few months ago, and I found by one side of his house on the highway where the roads met that he had built a little bit of a cozy dining cottage, with a pretty veranda and some beautiful vines growing over it. Inside was a cool comfortable place. In one end was a large cold-storage box, and he was selling milk and cream and ice cream, tomatoes and cucumbers, bread and butter and various other farm products. There was a great deal of bicycle travel past the place, and I found that he was selling his hay in another way to these people, — milk at five cents a glass is better than fifty dollars per ton for hay; and the milk in a piece of pumpkin pie or a cup of custard is an indirect hay market that is very profitable. His wife was attending to the selling, and they had a servant girl in the house. This man was turning a large share of his farm produce off in that way. Some one will say, "That is not farming." No, it is not; it is business agriculture. He has adjusted himself to the conditions. He told me what his income was, but I haven't the figures. Sometimes he did not sell all his milk; there were rainy days and things were left over;

but by good management on the part of himself and his wife he was making more than double the money he was off the farm before. His cream in the winter was sold to some one in town. The cottage was shut up. Do not tell me that is not agriculture. It is a high type of it. He is getting the best returns he can off from his farm. You are not all, of course, located on a corner, but it is a simple hint of what a man can do to adjust himself to the conditions. There are hundreds and thousands of other things which offer equally as good profit if the farmer and his wife catch on to the situation.

It is the duty of the business farmer to study more and more the conditions. Find out what the people want, and then give it to them. Find out what they want, and then produce it for them. Keep watch of the market. Early this fall a good, bright business farmer happened to be going to New Jersey on business. On his way through New York he found that quite low-grade apples were selling for \$1.50 and \$2.50 per barrel. He said to himself, "Apples are scarce just now." He dropped the business he was on his way to attend to, and returned home. The next day he had fifty or sixty barrels of wind-fall apples ready for market, and he got \$2 a barrel for them. The apples ordinarily would have gone to the cider mill. A little later, hand-picked apples would not have brought any more.

A few years ago a farmer of my acquaintance looked about the markets and found that the people of New England were very fond of nice beets early in the season. He built a little green-house and sowed beet seed, and after the plants were started he put them into pots. His neighbors laughed at him because he was potting beets. "Who ever heard of such an idea!" He grew them in these pots until it was safe to put them out of doors, early in April, and he had magnificent beets for sale, and sold them at a tremendous profit. He sold them in Springfield, Worcester, Boston and Providence, and created a magnificent business. Lots of people have imitated him, and the beet business has gone by and he has taken up something else. He has adjusted himself to the conditions.

I found one Massachusetts farmer way back away from the

railroad had a farm suitable for food products, hay, corn, etc. He put up a big silo and began boarding city horses. He kept them on ensilage and bran, and was getting a fair price for their board. He has studied how to winter them on this food cheaply, and turn them out in good condition in the spring. His farm is being enriched by it.

One of my western New York friends who is a successful man and who has made a good deal of money in agriculture says that he believed his whole success is due to his father getting up from the breakfast table one morning when he was a boy and going out to the road and buying a load of clover hay. The load was at the barn when the boy was through breakfast. The boy asked his father why he had bought the clover hay when already he had more hay than he wanted. His father said, "Never let a load of clover hay go past your farm. Sell your timothy and buy clover." He has been producing clover and selling other crops, but the clover, never.

I came across another little business trick that is business, In New York the other day a farmer — a Massachusetts or a Connecticut farmer would not have done it — shipped twenty barrels of Baldwin apples to market, all grades in the same barrel. The best offer he had was \$2 per barrel. The commission man thought he could get more for them, and re-sorted them. The twenty barrels originally would have sold for \$2 per barrel. He received for seven barrels \$3.50 each, for six barrels \$3 each, for four barrels \$1.75 each, and for two barrels \$1. They shrunk one barrel. He got \$50 as against \$40, or twenty-five per cent advance in the business transaction. Who gets the \$10? the commission man or the farmer? Whom did it belong to? They were the farmer's apples, but the New York man put the "business" into them. I will leave that to you. I do not know who got it, but I could guess. I know in many instances of that kind commission men who are sharp business men do work of that kind, and simply charge the farmer for the cost and give him the benefit. The commission man who re-sorts and repacks apples increases the value from ten to forty per cent; and they sometimes charge the farmer for the cost of the labor, less their commission, and give the farmer the

benefit of the re-sorting. I think if they would tell him the exact facts and keep the profit themselves, they would do him more good.

There are too many things that are "dirt cheap." Much of the fruit sold by the farmer lacks a proper handling to give it the most attractive appearance to the eye, and you must catch the eye before you can open the pocket-book very wide.

That is a pretty fair-looking apple, isn't it? [The apple referred to was held up where all could see.] Any one see anything remarkable about that apple?

"It is colored up." "It is a smooth apple." "About the right size." "Been polished." [From the audience.]

That came out of a bushel box of apples that sold in New York last week for three dollars. Some one will say it is not worth it. I do not know as it is. It is a smooth, fair apple, a bushel box of which sold at wholesale at three dollars.

QUESTION. What variety is it?

Mr. HALE. I think it is a York Imperial. It came from Colorado. I am not sure as to the variety. It is a good apple, but nothing very remarkable.

The CHAIRMAN. If you should undertake to make customers believe it grew in New England, you could not do it.

Mr. HALE. I'm not trying to make any one believe it grew in New England. [Another apple was shown.] Anything the matter with that apple? It is a beauty. It is sound, and free from blemish, practically. It is a Sutton Beauty, and it grew within fifty miles from where we are to-day. Does any one consider it inferior to the other apple?

QUESTION. How would that sell in New York?

Mr. HALE. There were never enough put on the market to find out. It has taken fifty years to find out how good it is, and a New York State man has done it. He is going to talk to you this afternoon. There is a business proposition. If this apple will sell in New York, I think some would sell in Boston.

QUESTION. Would a perfect Baldwin sell as well as that?

Mr. HALE. It might be a little too large. Brother Sessions told me he had an apple that weighed, — eighteen pounds, was it, you said?

Secretary SESSIONS. Eighteen ounces.

Mr. HALE. I knew it was something big. You will get the best price for a medium-sized apple. The apples must be uniform in size. Many a farmer might think if he put about a dozen of the biggest apples on top, he would catch the market. Better have them uniform. That is business. You have hundreds and thousands of acres of land in Massachusetts to-day that are almost worthless. It certainly is not earning five per cent on the investment. These apples might be raised on this land.

QUESTION. Do they sell better in boxes than in barrels?

Mr. HALE. I believe the barrel will go. The trouble with the barrel is, it handles too easily. A fellow rather roll it than pick it up. I think the finest apples will eventually be sold in boxes, or something different from the barrel.

A week ago, or something over a week ago, I was called by a business man in Pennsylvania to look over some farm property. He was willing to pay my fare, anyway, if I would give him a hint or two. He has made money in mining and commercial enterprises, and has been investing it in various ways. He has been investing for the last ten or fifteen years in farm property. He told me that so far as he could see there was no place where he could invest his money and be so sure of saving his capital and getting fair returns as in agriculture. His question at this time was whether it would be business to cut off the timber and put in chestnut trees. He has seen the orchards in Pennsylvania that had been cut away and grafted with Paragon and some of the other large sweet chestnuts. Was this a business proposition? Could he make it pay to invest his capital there? He knew he could make fair returns with corn and wheat.

Two or three years ago one of our western fruit growers was looking over the Massachusetts markets to find out what kind of apples you liked the best and would pay the most for. He spent some time in this way, and then went back

home to raise the apples and come here and take your business away from you or take your neighbor's business.

Really, whatever success comes in agriculture depends more on the man and woman who have charge of it than on anything else. The man or the woman, the boy or the girl, who believes thoroughly in the possibilities of New England agriculture, who knows that he can get as much or more from that than from anything else on earth, and who feels that he can get a living there, — that is the man to get at the business side of agriculture, and he is getting there all the time. The man or the woman must have, it seems to me, a thorough love for agriculture to become very successful. When Brother Jordan was talking yesterday about the young men entering into business where they could make more money than in agriculture, I was going to say, "Take them away. If they are going where they will get the most money, agriculture does not want them, no matter how much money you spend on them in college." If they go into some other calling because they love it, because they believe they can develop that branch of work to its highest possibilities, then I say to them, "God speed! go anywhere you will." Do that in life out of which you can get the most enjoyment, that in which you believe most thoroughly, and then you will succeed. The man who has a love for agriculture, for the brown soil, for the animals that should be fed thereon, that loves plants and bushes and vines and loves to see them grow, all regardless of finances, will be sure to get the very greatest financial reward. Show me a man thoroughly in love with agriculture, thoroughly in touch with nature, hand in hand with her, and I will show you a successful farmer every time.

I have in mind two farmers situated on the same farm, — not at the same time. One was an exceedingly hard-working man, and very "close-fisted." He had no love for the farm and no love for the crops on it. He would turn from one crop to another if he could get more profit by so doing. He was adjusting himself to financial returns only. I believe that is right to a certain extent, but his whole aim was to get money out of the farm, and if it was more convenient for him to build an ice house on the lawn beside his house,

he did not stop to think that it cut off a beautiful view from the family sitting room, but built his ice house. A little later it was a little more convenient for him to build a pig pen just at the left of the kitchen, and it went there. There were trees in front of the house which if he had cut away he would have opened up a beautiful picture of the river and valley beyond. He made money and paid the mortgage off his farm; but one day his daughter, who had not seen much of life, ran away for the sake of going somewhere. A little later his son skipped out with \$260. Now the old man is crippled mentally and physically, but he has got some money. Now he cannot work his farm, and he is living on his money and hobbling around all the time.

The other man had a bigger mortgage, but he got the ice house out of the way, the trees out of the way and the pig pen out of the way, and has been cutting brush away and planting shrubs, and has generally improved the place in its appearance, and he has not paid off the mortgage. He is a success as an agriculturist and the other fellow is a failure from the business point of view, even though he got the most money.

What are we carrying on agricultural operations for? For the sake of making money for money's sake? Not a bit of it. You want it for what it will give yourself and your family; for what it will enable you to do in a public way, for the good of the public and your family. The one great thing is what you can get out of it for yourself and your family.

I had many points that I wanted to touch on, but I do not believe there is time. There are a good many things to be talked about along this line.

The spraying which was spoken of yesterday is a plant life insurance that we cannot afford to neglect. There is a wonderful chance to improve by working along this line.

We do not want to expect that the experiment stations and the colleges and the law makers are going to do everything. We are expecting altogether too much from them. They are doing a grand work and are capable of doing great things, but we are beginning, are we not, to lean on them too much? Are we doing enough for ourselves? We certainly cannot expect them to do everything for us. They

are making a great deal of talk about the San José scale. Do not be frightened. The codling moth is a hundred times worse and has done more damage to the agricultural industry of New England, and yet you simply let it go, because in spite of it you can get some good apples, while the San José scale will soon kill your trees if you do not check it, so we are forced to spray and kill the scale, and good will come of it, for while fighting it we are getting acquainted with our trees and learning their wants.

I want to give you a suggestion for the future: guard your trolley legislation in this State. Be sure to be able to utilize everything you can along trolley lines for agriculture. There are wonderful opportunities for broadening out our agriculture and in handling our agricultural products. The other day I was riding on an electric car and we went by a certain house, and the motorman rang his bell and the conductor held up three fingers. I knew there must be a pretty girl in that house, — any good girl is pretty, — I wish the men could match them. I wondered what those three fingers meant. When the car came back a little bundle was brought out from that house. This man's run was right in the middle of the day, and he had acted as an agent for his neighbors. This family where we stopped were producing butter and eggs and chickens. This time he wanted three broilers, and the girl knew what he meant and she had them ready when the car came back. It gave me a hint of the distribution of farm products in that way. You are building trolley lines all over the State. Are you getting the privilege of transporting freight?

I have said practically what I had to say about the final results of all this work, — of making home life what it ought to be. There is an opportunity for the Massachusetts farmer to get more out of life in its broadest and best sense on the farm than anywhere else. To do this it needs money and capital that must be gotten out of the farm with the best of business methods and a love of the business. By adjusting ourselves to new conditions we may find great opportunities on the farm in New England. We have the best markets anywhere on the globe. Go anywhere in America and find a man who is producing a high-grade

product, and you will find that he expects to send a large proportion of it to the north-eastern portion of the United States. The soil of New England in its various grades and qualities has the possibilities of a very wide range of product. Adjust yourself to the conditions, somewhat to your farm, somewhat to your market, largely to the cultivation of what you believe in, and put your whole heart and soul into your work, and there is a possibility, it seems to me, of great results.

I was particularly interested in an article in the "New England Farmer" last week, giving an account of what our friend Cheever got out of a half-acre of land. He supplied his own table bounteously throughout the season, and I think he sold \$125 or \$130 worth off from that half-acre. He told of sitting down to many a meal almost entirely made up from the products of that little farm. What must he think of those who have tens and hundreds of acres of land, and do not have the wonderful variety he was having off his half-acre? There are many farmers who do not know the taste of certain varieties of vegetables. You have them here in this audience. If you take an acre and devote it to a great variety of fruit and vegetables, there is a business prospect in it and a home market in it; produce on it everything your family can enjoy, and you will find a business profit there that you never dreamed of before.

The CHAIRMAN. We shall be glad to hear from any on this subject. Will President GOODELL of the college address us?

President GOODELL. We have heard of different kinds of business here to-day. We have to do here at the college a great deal of work that may seem to you is not business, and yet it is business in a certain way. We pour out money for experiments that you farmers cannot undertake, but it is all for your benefit; and you are supporting us,—you are taxing yourselves to support us to do this work. It is business for you, not for the college. It is not paying the college, but it is business for you. You put in costly laboratories, all kinds of apparatus; and, while it is not every man that goes out from the college that makes the right use

of it, the man who does make the right use of it has gone out into life better fitted because of these laboratories. It is business to him. It is not so much for the immediate return, but for the return that comes later.

The farmer will send his son here to the college, and spend five, six or eight hundred dollars, but he does not expect there will be any immediate business return to him; it is not going to bring money to him immediately, but it helps his son to make the most that is possible of life.

Professor BROOKS. I crave a few moments' indulgence to present the business side of agriculture from the stand-point of a young man who graduated from our college a few years ago. I have spoken of this young man and his experience at a meeting of the State Board, in Dalton, I think; but there are many here to-day who were not in Dalton, and I trust that those who heard me at that time will be willing to pardon the repetition.

It has been said that a young man graduating from the agricultural college has no capital. If a young man loves the business of agriculture and is determined to succeed, he can do it even if he has not a dollar of money. This young man before graduating came to me and said, "I have been here now four years, and I have acquired a great deal of knowledge that I believe will be useful to me on the theoretical side, but I want to get at the business side." He said, "I think it would be a good thing for me if I could find a place to work on a farm of some successful farmer, where I can get at the business side. What do you think?" I told him at once that I heartily approved of his plan, and asked him what line of farming he was thinking of going into. He said, "I think market gardening." He asked if I knew any one who wanted help, and said he did not expect much pay. "If I am worth anything, I shall be glad to get it. My main object is to learn the business side of farming." Fortunately I did know of a successful market gardener in Winchester, and, writing him, I persuaded him to take this young man. He went there and donned his working clothes, and started in the field with forty or fifty men. He saw that they were laughing at him and commenting that he would have a sore back before night. He said, "I determined to

show them what I was made of." He showed the same spirit right through in the brain work as well as in the muscular. He won the hearts of the people who owned and managed the farm. At the end of about a year he went to the owner and said, "I think I have got a little insight into the business side of market gardening, and now I think I must leave you." He thanked the owner for the favors he had received, etc. The old gentleman said, "I am very sorry that you are going, but I cannot advise you to stay. Your time would be worth more to you in working for yourself. I want to say to you that if you need any capital to begin work for yourself, I am willing to lend you all you need." I do not know whether the young man availed himself of that offer, or not. He hired a farm, and the first year succeeded very well, and within a very few years was in a position to buy a farm. I believe he did not pay for it at the start, but he is doing well. What this young man did, other young men can do, but they must love the business, they must be as determined to succeed as Mr. Hale was when he fought the witch grass. When I was about fourteen years old, a brother and myself were turned into a field of witch grass. I always tried to do thoroughly whatever I undertook, and we hoed that field so thoroughly that there has never any witch grass grown there from that day to this. With a love for the business and a determination to succeed, a young man who will come to us and get the scientific side of agriculture can succeed even without capital.

There is just one other point, and one on which I have no doubt the speaker will agree with me, because his practice accords with what I am going to say. I believe there is too much small farming. Extensive farming should be followed. It takes a hundred-acre man to be a hundred-acre farmer and a thousand-acre man to be a thousand-acre farmer; but what you young men want to do is to fit yourselves to be thousand-acre farmers, and then be such farmers. You can succeed and you will make money. Of course you can make money on a small farm. But if you go into extensive farming with determination and with love for the business, you can all succeed.

Dr. JORDAN. I do not want our friend from Connecticut

to lose all the fun that he anticipated in trying to stir me up, as he said he was going to. He tried to put me in the place of Mary, the servant girl, but I am not going to let him do it. Mary, like all sensible girls, got engaged to be married. They all mean to. When she went to confession she was full of the new joy, and she had a right to be; and she could not help confessing to the priest that she had just become engaged to be married. It so happened that in the midst of the conversation she let slip the statement that Patrick had kissed her. The priest, smiling behind his eyes, said, "Mary, didn't Patrick kiss you more than once?" Mary understood that the priest was guying her a little, and she said, "I came here to confess and not to boast." Brother Hale wants to make me a confessor with no boasting. I wonder if he knows where I live? Has he seen from where the New York station stands the success in agriculture in its highest forms where there are as good agricultural opportunities as are outdoors? Does he suppose that I come from that place, with such a man as Brother Willard and some others before him, and say that there are no opportunities in agriculture? I do not know whether he reads his Bible or not. I begin to doubt it. He is like a piece of red glass. He observes some things and leaves others. He heard some things I said, but did not hear the rest. I say "Godspeed!" to every young man who has ambition in agriculture. If I had any hair, it would be full of hay-seed. I love the country. I grew up on a farm. I did not go back to the farm because I got so interested in the study of things that pertain to agriculture that I could not leave it. If I had been called to a large farm, that would have been my place. If I had been as good a citizen and as good a farmer as I had the privilege of being, it would have been a life of success, I have no doubt.

Mr. S. D. WILLARD (of Geneva, N. Y.). I have listened with a great deal of interest to Brother Hale and to the others who have spoken. I was particularly interested when Brother Hale hit upon an apple that I am extremely fond of, and I want to say just a word about that which perhaps I should not have said otherwise. Thanksgiving Day, in thinking of my friends who ought to be taken care of, I happened

to think of my own State senator, of whom I am very fond. I said, I will send him a barrel of Sutton Beauty apples, for I think I know his weak point, and I can tickle that stomach of his as quickly in that way as in any way I know of. We accidentally met on the cars a few days ago, and in the course of the conversation, which I afterward repeated to Professor Jordan, he said, "I want to know just exactly the name of that barrel of apples you sent me." I said, "Why, what was the matter with them?" He said, "I have eaten them nearly all up. I have never put into my mouth at this season of the year an apple that suited me so thoroughly as this one. It is sufficiently acid to be just exactly the most desirable apple I have ever eaten at this season of the year." I told him I was very glad of it.

In that apple we have something more than simply a good-looking apple and a good-eating apple. While we are making every effort possible in the lines of economy, we find continually that there are expenses being involved in the production of everything. In order to be successful in apple growing, we have got to spray. We have to spray almost everything. From my own experience — I do not know how it will be elsewhere — I find that the Sutton Beauty requires no spraying to guard against fungus. I get a good crop every year without any Bordeaux. It has a foliage that is almost perfect, and that is the beginning, the foundation of the whole thing, — if you haven't a perfect foliage, you had better hand it over to your wife's relatives. I did not get up to talk apples. That will come later, perhaps. What I want to get at is that there is an apple that has a foliage that is so perfect as to avoid the necessity of spraying the trees with Bordeaux. If we can get into these things and find out about them as can be done at the college, and ascertain what such varieties as need no spraying or very little are, and then get Hale to tell the people throughout the country what they are, we will get them.

In the month of September last, at our State fair, on a little branch of apples suspended in our horticultural department (Professor Fernald will smell the thing out now) was a branch or two branches of apples, one bearing about twelve apples to the foot, and the other, if I recollect right,

about fifteen apples to the foot or perhaps two feet. They were making an exhibit there for a purpose, and that was to show what could be done in producing apples without a blemish.

The CHAIRMAN. These apples were not thinned.

Mr. WILLARD. The remainder of the apples were thinned. A few weeks after that Professor Waugh from Cornell University called at my place and incidentally found my men sorting these apples and packing them for market. Professor Waugh said he knew the apple very well, and also said, "Willard, if you had not grown these apples and had not told us what the variety was, we would scarcely have believed it, simply because we have never seen apples of that variety of that size." I told him all that had been done was to thin them. Professor Waugh said, "We have never seen them so large, and I believe there is more in the man than there is in the fruit." I told him no, there was not much in the man.

What I am trying to get at is this: the apples should have matured in October, but they matured in September, simply because the season had been advanced. They brought four dollars per barrel in Philadelphia. There is business. There is an apple that will give perfect fruit without the expense of spraying, and they will practically sell themselves.

Secretary SESSIONS. Did you mean to be understood that this particular apple will be safe from insects without spraying or simply from fungus?

Mr. WILLARD. They were sprayed for the codling moth. We can develop a line of apples that has a foliage so perfect as not to require spraying because of fungus.

Mr. HALE. Just one word: I hope you have listened to every word that Brother Willard has said. He is the most successful business fruit grower in America. The one thing he dropped there is worth thousands, yes, millions of dollars, and that was, *thin your apples*. If you do not listen to him this afternoon at all, go home and remember that one thing and you will be enriched by his coming here, — tremendously so. Thin your apples. That is business.

Mr. BENJ. P. WARE (of Marblehead). You said a medium-

sized apple was the most desirable. If you thin your apples, you get larger fruit.

QUESTION. What size should the apples be when the thinning commences?

Mr. WILLARD. That depends very much on the circumstances and the judgment of the man. Our apples are not as far advanced one year at a certain time as they are another. Be sure all the early droppings are over.

QUESTION. How large should the fruit be in size?

Mr. WILLARD. Those apples were thinned the latter part of June or July. They were not a quarter grown.

The CHAIRMAN. We will now adjourn until 2 o'clock.

Adjourned at 12.15 P.M.

AFTERNOON SESSION.

The meeting was called to order by Secretary SESSIONS, who said: the vice-presidents and the executive committee have asked Mr. E. W. WOOD, second vice-president of the Board, to preside this afternoon.

Mr. WOOD. The subject selected by the committee for consideration this afternoon is in part a continuation of the subject of the forenoon. If the speaker has ever been through the farming sections of Massachusetts, he will have seen that the subject selected for him to consider is ample; if he has ever seen our orchards, neglected as they are, where the crops are simply accidental, he will see the necessity of discussing this question which the committee has proposed, which is, "The place that fruit growing should hold in New England agriculture," by S. D. WILLARD of Geneva, N. Y.

Mr. WILLARD. It is needless for me to say to you that I regard myself highly honored in having an opportunity to speak to you this afternoon on the subject which has been referred to. I feel it more particularly for the reason that my early opportunities were not such as to fit me to address an audience of this kind, and I am simply drawing from my own observations and experience in what I shall say to you. Further, my friend, Brother Hale, this morning seems to have anticipated in a measure what I shall talk to you about

this afternoon. Perhaps that is, however, the outgrowth of the fact that we are both figuring and talking on economic lines. It is the commercial stand-point that I figure on, and I know he does the same, and in my opinion it is what we all ought to figure on.

I say I regard myself honored in having an opportunity to speak to an audience of representative men from all parts of this Commonwealth, and, without any words of apology, I wish to say that I do not believe in the whole United States can be gathered together at a meeting of this kind to consider and consult on these subjects such bodies of men as are here. I know we cannot do it in the Empire State. It is with difficulty that we can get them together for one day, to say nothing of two or three days.

THE PLACE THAT FRUIT GROWING SHOULD HOLD IN NEW ENGLAND AGRICULTURE.

BY S. D. WILLARD, GENEVA, N. Y.

The agricultural interests have great reason for encouragement, in the fact that at no time in the history of the country has the same interest been manifested in efforts to extend useful information pertaining to the requirements essential to success in all lines of farm work as to-day. State and Federal legislation are extending ample aid in maintaining farm institutes, agricultural colleges and experiment stations, which are in turn doing a work the importance of which can hardly be estimated.

Said one of our good farmers to me a short time since, "If the work of the New York State Experiment Station had been limited to the analysis of fertilizers alone that are being sold by manufacturers in our State, I believe the benefits that have accrued to the farmers from this service has resulted in an annual saving to them of a sum sufficient to pay the entire expense of maintaining the station." Be this as it may, the illustration is an apt one, as showing what the State is doing in a single direction for the promotion of agriculture; and it should be an incentive to all whose interests are involved to increased effort and investigation upon all subjects pertaining to crop production. In doing this, it may be wise to bear in mind that a system of evolution is at work, and the conditions of half a century since are in no sense the conditions of to-day. The world is moving at a pace requiring activity of the highest order to keep abreast of the times. The conservatism of a former generation must give place to the spirit of aggression that has marked out national progress in every undertaking, and in this our agriculture should be found in the front ranks. Our State institutions are furnishing the theories

and principles the practical results and benefits of which will be realized only as worked out in the experience of the farmer. Hence we meet to-day to discuss affairs that aid in the solution of important problems. These experiences are varied in their character, while observation and comparison of views aid to intelligence and increase of such available knowledge as is required in the attainment of the ends sought.

Hence the utility of the annual gatherings of those engaged in a common cause, and the growing interest in them is a sufficient vindication of their importance. Environment is a factor too often lost sight of in considering the character and tastes of the individual whose development has been the outgrowth of early surroundings. My father, a native of your own State, was one of the early settlers of a section of western New York that has ever been celebrated for its grain productions; indeed, as an excellent wheat-growing region it has never been surpassed, while a mixed husbandry, including stock growing of all kinds, contributed to the prosperity that in those early days caused it to rank as one of the wealthiest agricultural sections of the State. He was a good farmer, who believed in and practised crop rotation in the growing of such varied crops as were adapted to the soil and wants of the times. He was among the first to attempt apple growing. A small orchard was planted to native fruit that later on was grafted to the *Æsopus Spitzenburg*; and well do I remember, when a boy, of picking six and eight barrels of beautiful fruit to the tree, which was the admiration of the whole country, that were sold to others who had not appreciated the capabilities of the region for such products. Other apple orchards were started in that and other counties, until the industry has become one of great importance and profit.

About 1845, a neighbor, whose opportunities had enabled him to lead others in horticultural pursuits, conceived the idea of planting a pear orchard, the seed of which was secured from a few road-side trees in the vicinity. Later on they were grafted to Bartletts, the scions of which were procured near New York. This was the first Bartlett orchard in the county, the product of which was shipped to market

by the Erie canal, at that time the only medium through which were transported to market the entire crops of the country. From the beginning the undertaking was profitable. One of the first heavy crops was sold in New York City at \$15 per barrel. A stimulus was thus given to pear growing which has continued notwithstanding the prevalence of low prices in later years, and the pear continues to be grown as one of the staple fruit crops over a wide area, the production finding its market either in distant cities or in canning factories that require thousands of barrels annually to meet the demands of their growing trade.

It may not be surprising that amid such surroundings has been developed a taste that has led me to regard fruit culture as one of the most important and valuable branches of farming, and I believe the ground well taken. Good orchards of all fruits have a fixed value that has been well maintained. They are rarely found for sale, their estimated value being at from \$200 to \$1,000 per acre, the difference in price growing out of the location, condition and varieties grown, the latter being regarded as a matter of great importance, but which in many instances has been too little thought of in planting for commercial purposes. A friend who is known as one of the best apple growers in my county has assured me that \$1,000 per acre would be no temptation as a purchase price for his orchard; he claiming that his plantation of Nonesuch and Baldwins has paid him more than 10 per cent net on this sum through the past ten years. The past season, with only a moderate crop and an unusual amount of defective fruit, the receipts from about 25 acres have amounted to something over \$4,000.

Now, how about the value of ordinary farm lands in general through the same section? A hasty review of the situation may not be amiss. A portion of the land owned by my father, independent of the old orchard referred to, sold some forty years since at \$135 per acre, and it has recently changed hands at \$60 per acre. And this is no exception. The depression in value of all farm lands has been general, until they have come to be regarded as unsatisfactory and uncertain security. The causes that have led to the changes are various; but in the main the princi-

pal factor has been the opening up of the fertile sections of the far west, which, with the rapidly increasing facilities for cheap transportation and improved appliances for producing and securing everything grown, has afforded competition so sharp that grain growing and stock raising have no longer any attraction for the New York farmer.

In the mean time, no such depreciation has taken place in the value of well-located farm lands of the west. It is true that they have suffered amid stagnation that has attached itself to the value of real estate everywhere, but prices have been well maintained, if not enhanced, and indebtedness incurred in their development has been largely liquidated, showing that the requirements for existence of the human family can be grown and placed upon the markets of the world at prices affording a profit in one section that would be only loss and ruin in another. How far this condition may apply to the situation in New England, I leave for you to determine; but it is suggestive, and to my mind, where the possibility exists, a more diversified system of agriculture should prevail, and the growing wants of the rapidly increasing population of our cities and manufacturing centres more thoroughly studied and better understood, with the view of growing and supplying such products as can be grown cheaper and more profitably than in those remote sections, better adapted to other purposes. It is in this line, in my opinion, that we must look for future success in our agricultural work. The rules and principles that are applicable in my own State, to a certain extent I believe will be found to hold good in New England. Hence I stand as an advocate for more extended work for fruit growing upon such soils and in such locations as experience has shown are adapted to it.

The question of to-day is, has the profession of fruit growing yet been elevated to the position to which it is entitled in considering its relations to the agriculture of your region? Are there not thousands of acres of fields that might profitably be planted to some of the many fruits required to meet the wants of the consumer, that are now produced in some remote region and transported at an expense that of itself would afford a fair profit at home? This

I believe is worthy of your serious attention. Adaptability of the plant to the soil and environment is of vast importance. In fact, it is one of success or failure, as is in evidence continually, and must be studied and decided only by the individual whose interests may be involved.

One fact, however, is patent to the mind of every intelligent observer, and that is, that fruit of every name and nature is wanted by some one, and that its consumption is rapidly on the increase. Nor will the demand for it ever grow less, but will keep pace with the growing intelligence of a rapidly increasing population.

Beginning with the gooseberry and currant, that are easily handled and well fitted for long-distance shipments, I have found them grown with profit. They seem to thrive best on a cool, moist soil, on which the foliage holds well into autumn. The President Wilder and Prince Albert, by reason of their great productiveness and good shipping qualities, are our favorites as currants, while the English sorts and Downing gooseberry pay best as gooseberries. The increased demand at home and abroad for the product of canning factories and evaporating houses have made them large consumers of all tree fruits, and should give increased confidence to those whose lands are adapted to the production of the apple, pear, plum, cherry, peach, apricot and quince, each of which are profitably grown where intelligent industry and business principles prevail. In the commercial orchard there is much in the variety, also much in the man. The latter may be an expert in planting, directing and executing, but it is rarely he can make a naturally unproductive soil sufficiently productive to leave a margin of profit after paying the cost of growing. A wise discrimination, therefore, should be exercised between varieties grown for home consumption, because of their exquisite quality, and those whose prolific tendency specially fits them for market purposes. A disregard of this principle has been the fruitful cause of much dissatisfaction and failure on the part of many modern fruit growers. Quality should not be lost sight of, but productiveness and beauty count for more with the commercial grower, and the instances are rare where a happy combination of each are found.

The apple, the king of all tree fruits for the production of which New England has been justly celebrated for years, deserves greater consideration than is usually accorded it; and, in my opinion, the agricultural interests here represented would be acting wisely in urging a more general planting of large areas of apple orchards at this time, when in the fruit regions of Michigan, Ohio and New York this industry has been greatly neglected. In the sections referred to the plantings of forty and fifty years since are rapidly passing away, and to a great extent, except in a few locations, but little effort is being made to replace them. This, too, in the face of an increasing demand from the British Isles and various European countries for choice American apples. What more encouraging field for the New England agriculturist, who has the soil and location suited to the culture of this fruit?

The various insect pests are increasing in their work of devastation, with no effort on the part of the slothful to prevent it; hence the opportunities are constantly widening for intelligent ambition, that are full of promise.

For years fears have been expressed of the over-production of the apple; and I have in mind instances where parties have uprooted young orchards just coming into bearing, some of whom have lived to regret the mistake. It is claimed by one well posted in the apple industry, that, taking the country through, not to exceed one-sixteenth of the apple trees procured of the nurserymen ever live to be commercially productive. This on account of improper selection of sorts, of subsequent neglect on the part of the average planter, etc. If this be true, and I am inclined to think it may be, the danger of over-production is quite remote. Again, another assuring feature of the industry is that in the apple regions of the United States and Canada there is little chance of a crop bearing heavy or even fair in more than one-third of the apple territory in any one year; and this must continue to be so to a greater or less extent, until the habits and wants as well as the varieties themselves are better understood. There certainly is room at the top for the apple grower of the future.

I have referred to the pear as one of the profitable orchard

fruits, but I should add that the list of varieties adapted to the wants of the commercial orchardist is very limited. The Bartlett, Bosc, Winter Nellis and Kiefer are among those that pay best. The latter as a canning fruit seems to be growing constantly into favor, and whatever are not required to meet the wants of the canning factories find ready sale in the city markets. They are grown cheaper and sell higher than most other varieties. While there has been a manifest falling off in apple planting, there has been a corresponding increase in the acreage put out to most other fruits, and especially so with the cherry and plum, both of which for years were on the neglected list. More perishable than the apple, and accompanied with more risk in producing, a demand has sprung up in recent years for these fruits that has made a ready market for all grown. The Montmorency Ordinaire, English Morello and Windsor are the sorts generally in demand. The two former are required in large quantities by the canning factories as well as in the city markets, while the Windsor supplies the fruit stands with the largest and most excellent fruit of its season, with no probability of a surplus for years to come. It is rarely sold at less than ten cents per pound at wholesale. The magnitude of the sour cherry interests may be better understood and appreciated, were I to say that the annual crop of two parties of my acquaintance amounts to between 40 and 50 tons, which is picked for market at an expense of about \$1 per hundred weight. It is usually sold at from \$100 to \$120 per ton. As grown in the locality referred to, these varieties are but little inclined to decay, and are quite free from the depredations of birds, hence they are special favorites among orchardists.

For years the culture of the plum was largely confined to the region adjacent to the Hudson River. Indeed, commercially considered, the business may be said to have had its conception there, from which it has moved westward, and to-day has become one of the largest of the fruit-growing industries. The European sorts, comprising a few varieties only, are principally grown, and will be for years to come, while the advent of those of the Japan type has given a fresh impulse to the business that is likely to con-

tinue. The Abundance was first introduced, followed by the Burbank, which, by reason of its superior shipping qualities, great productiveness and acknowledged value as a canning fruit, heads the list as a favorite orchard sort. The Satsuma is gradually growing into favor, with sentiment divided as to productiveness and quality, while the color is against it as a market sort. Of more recent introduction, the Red June has shown itself to be wonderfully hardy in fruit bud, very early in ripening, its fruit of good quality, and so attractive in color as to command the markets on which it is placed. Wickson, October Purple and Hale complete the list of these seedlings of foreign parentage destined to work a revolution in American plum growing. The Wickson, while of excellent quality and great beauty, has, up to the present time, failed to show sufficient productiveness to entitle it to a place in the commercial orchard. The trees make a strong growth, and at this season of the year, as usual, are loaded with fruit buds that give an enormous bloom, but fail to set the fruit. It is possible that with increasing age this fault may be changed. To my own taste the Hale excels all others in quality; while the October Purple, maturing its fruit quite late and being so attractive in color, will, without doubt, supply the requirements and great demand for a late plum. It may be picked green, and in the course of ten days or two weeks will be found to color and mature perfectly for market.

The quince, more fastidious in its requirements than many kindred fruits, is yet grown to perfection on most lands where the apple and pear are found to thrive, and, by reason of its fitness for long-distance shipments, is a favorite fruit with many growers, some of whom claim that it can be produced at less cost than apples.

With a better knowledge of the wants of the peach and apricot as regards soil and location and the development of varieties, the fruit buds of which are specially fitted to withstand the extremes of our climate, the cultivation of these fruits is considerably on the increase, adding to the list of those productions destined in the near future to revolutionize the system of agriculture, which, while adapted to the

wants of a former generation, is in no sense meeting the requirements of the present day.

Let me not be misunderstood. If satisfied with results obtained under a system in which commercial fruit growing has found no place, continue the work with such intensity of purpose as you possess; but if, on the other hand, you see fit to add other interests as circumstances may seem to warrant, it is quite likely that the culture of some kinds of fruits might afford inducements worthy of consideration.

It has been my purpose to give you a hasty review of my own experience and observations in the growing of such soil products as are accompanied with more profit on the good farm lands of my own State than are those crops so successfully grown west of Lake Michigan, with the belief that some or all of them will be found adapted to a large portion of the territory represented by the Board here assembled.

Features of the work of great importance, such as pruning, feeding, spraying, cultivation and commingling of varieties to insure fertilization of bloom, have been omitted, as also with some exceptions reference to varieties. These are all topics of interest and are proper subjects for discussion, but too lengthy to be taken in detail in considering the subject upon which I was invited to give you some thoughts from my own experience.

And now, thanking you for your kind attention, if I can add anything of interest by responding to any questions that may suggest themselves, be assured it will afford me pleasure to do so.

The CHAIRMAN. The speaker has opened a field that will offer you an ample opportunity to ask questions, and he holds himself in readiness to answer as best he may the questions you ask. Owing to his location, many things that might be best for him might not be best for you. In this section the pear interest is not to any great extent carried on as a commercial venture. In the eastern part of the State it is grown for the Boston market. There is a wide difference in different localities. Mr. Willard is ready to answer any questions.

QUESTION. Can apple trees be made to bear every year?

Mr. WILLARD. I know an orchard that produced an immense crop in 1896, a fair crop in 1897 and a good crop in 1898. These instances are somewhat rare. There is something in the man, as well as in the tree. This man is a good cultivator, a good feeder; he thinned the crop in 1896 with reference to the fruit that would come later. You must lay the foundation in advance. You cannot do the necessary work the year the fruit is grown. It must be done before. His work was always ahead. He can figure pretty closely on what his receipts will be annually.

I do not know but I shall take up Brother Hale a little now on what he said about insect pests. He and I disagree a little bit, I found to-day, in regard to some features of the insect pests. As I crossed the line yesterday when coming into your own State, I noticed the neglected apple trees along the road (very much the same as in my own State), and I thought, what a beautiful place in these neglected apple trees for the breeding-places of these insects which we hear so much about and know so very little about. Now, we have the oyster-shell bark louse and the scurfy bark louse and the tent caterpillar and the canker worm, and, last but not least, we have the San José scale. My own impressions are from a slight investigation into this matter, that we know but little as yet concerning the extent to which this insect is disseminated. We know it has been very abundant in New York, and that it is not only plentiful there in my own State, but also throughout New England; and I want to say to you that the further I have gone in investigating this matter, the more fully I am satisfied that we do not know very much about it. In the first place, I believe it is scattered over a territory far beyond what any one has anticipated. The farther we go the worse we find it in New York. At first we supposed it was confined to Long Island. There have been trees enough destroyed there to bankrupt somebody. It is now way up the Hudson, there are orchards there where it can be found. This scale is more dangerous, because it is insidious in its work. You would have to call in an expert with a powerful microscope to detect it, yet it is doing its work. It is eating out

the life of the trees. What are you going to do with it? We have taken hold of it in New York and got \$10,000 appropriated last winter. I do not know as we are ever going to exterminate it, but I do comprehend that it is going to require considerable work before we can say that we have it in check. If you or I or some of our scientists could tell just how it is disseminated, how it spreads, how it is carried from tree to tree, the case would be somewhat different; but I have not yet seen the man who is wise enough to tell me. You may go into an orchard and find a tree infested, and skip ten or fifteen trees where you will find none and then come to an infested tree. I do not understand it, and I do not know as anybody does. Some varieties of trees are somewhat exempt. It is rarely found on sour cherry trees, while it will be found on the sweet. I think I differ with Mr. Hale on the question of this scale.

MR. HALE. Not a bit.

MR. WILLARD. I am glad to hear that we agree once.

QUESTION. Does the scale work on young trees?

MR. WILLARD. Yes, sir. If you can find anything under heaven aside from the few varieties I referred to that it will not eat, I would like to see it. It will attack the currant, and I have seen gooseberries literally riddled with it. I do not know of any effectual way to get rid of it except to burn it up.

We are going to ask for \$20,000 this year. It is a big job to handle this scale, perhaps equivalent to handling the gypsy moth here. I have tried to make the bill cover all insects, and therefore put in the words, "any other dangerously injurious insect pests." That includes the caterpillars and the gypsy moth, if you should allow him to cross our line. We are trying to protect our orchardists. I believe we are entitled to protection as much as some of the men in New York who are connected with Tammany. It seems to me, from what I know about it, that it would be a pretty wise thing for you to study it in your State. I do not advise you to adopt the same measures that we have, but have inspectors to inspect your trees, and so far as possible allow nothing to be dug and sent out unless it has the inspector's card attached to it, saying that he believes it to be

free from anything of the kind. I understand that as yet you have taken no steps in this line. I do not believe I would allow a New York man or a New Jersey man or a Pennsylvania man to ship anything to me unless it bore the card of the inspector, and then I should want to inspect it myself. To-day would be a grand day to inspect for the scale. On a cloudy day you can hardly detect it with the naked eye. One day last week an inspector brought in several sticks and laid them on the table before me, and I put on my glasses and could not detect anything that looked like the scale, but under the microscope I could see it there at work preparing to next year hatch its millions.

SECRETARY SESSIONS. Do the sour cherries go to the canneries?

MR. WILLARD. Some are sold to the canneries. You can pick them every day in the week (except Sundays) for the canneries, and can pick them without the stems and they are much more cheaply handled. If you pick them with the stems, they have to pick the stems off.

The canning factory should go hand in hand with fruit growing. A large canning factory consumes not only fruit, but pumpkins, squashes and almost everything else. I know of four canning industries in the State of New York that consume annually thirty thousand bushels of Bartlett pears. They pay usually about a dollar to a dollar and a quarter a bushel.

If I were planting a plum orchard to-day, I should plant a certain number of rows of plums, and I would put in a row of cherries here and a row there. It would not be for the fertilization of the blossoms so much as to protect them from the curculio. We bug our plums, but the cherry trees are never affected.

QUESTION. Are you troubled with black-knot?

MR. WILLARD. You have no business to have it in your orchard, and no other man has. You have no right to propagate a nuisance.

QUESTION. How can you help it?

MR. WILLARD. Cut it off. I have never seen the Japan plum affected with the black-knot.

QUESTION. How do you "bug" your plums?

Mr. WILLARD. By using machines, of which we have twenty-five now. Our machine is about like an inverted umbrella on an axle. We jar the tree, and the bugs fall on the inverted umbrella. Ours is nine feet across. It is light in color, and you can readily see the insects upon it. We take a broom and brush them down to the point of the umbrella into a tin box and at the end of the row we empty them into a fire box. One man will run that machine around about seven or eight hundred trees in a day, and it would take two men with a sheet. I do not know as this is the best way, but it is the way we do it.

Mr. SEARLE. How often do you have to "bug" them?

Mr. WILLARD. That depends a great deal on the conditions. If the weather is cold, we "bug" every day for the first week and every other day the next week. If the weather is warm, so that the insects are active, we would perhaps have to run it two weeks every day. We run it right through the day. Some of our neighbors run it right through the week, Sunday and all.

Mr. STRATTON. I have several plum trees, and last year they bore very full and seemed to be doing well, until just before they were ripe a little black spot started on each plum, and the plums decayed and we got almost no plums.

Mr. WILLARD. If the case were mine, I should advocate spraying the trees with Bordeaux mixture after the blossoming period had passed and the plums had set. I think a great mistake is made in spraying at the wrong time, — when trees are in bloom.

Mr. HALE. The speaker seems to think we differ somewhat on the matter of the danger from the San José scale. He probably gathered that from what I said this morning. I said I did not believe the San José scale would ever do the damage to our apple industry that the codling moth has, and I do not believe it, for the reason that the codling moth has been working for years and years, and has given us anywhere from seventy-five to ninety per cent of damaged fruit year in and year out. The codling moth will not kill your apple tree, and the San José scale will; and, from the fact that it will kill your trees, you must look out for it. I am with the speaker heart and hand on this question.

I was interested in what he said about the Satsuma plum. We have all been a little shy about planting many of them, because they do not bear as quickly as some other varieties that begin to bear fifteen or twenty minutes after they are planted. When it gets well established, after five or six years, it begins to bear tremendously of plums of good size, although rather off color, being a dull livery red; and they will keep two or three weeks if necessary after picking, if picked right. There is a continual demand for them. People want them, and at high prices. All of us have been overlooking it.

I would like to ask Brother Willard how far apart he plants his trees.

MR. WILLARD. Twelve by sixteen feet. I had one lot put in sixteen by sixteen, and I made up my mind it was two valuable land to fool away in that way. I began to figure up how long I was going to live, and I made up my mind I had better "double up," so I had an additional row put in, making the trees eight by sixteen, and I am satisfied that with my method of handling it is going to be a success. I would not advise some other fellow to do the same as I do.

MR. HALE. Why twelve by sixteen? Why not equal distances?

MR. WILLARD. We can use our machines better with the trees set in this way.

MR. PRATT. Do I understand that twice a year is sufficient for cutting out the black-knot?

MR. WILLARD. I find twice a year sufficient. We go over our trees in the month of June for the black-knot. Our trees are covered with fruit and our other work is pressing, so we do not get an opportunity to do it again until fall. At this season of the year the spores of the black-knot are being spread; hence we cut them off and have a bushel basket in which the stubs are put as we cut them off. Perhaps we will have a limb four or five feet long to cut off in order to get at the affected part. We cut the limb off below the knot, then cut the knot from the limb, dropping the limb to the ground and putting the knot into a basket. These baskets are put into a wagon and taken to

a heap, where the knots are burned at once, to prevent the spreading of the spores. The limbs are afterwards gathered. I suspect that as long as we grow plums — and we shall continue to do it as long as there is anything in it — we shall find more or less black-knot, but by cutting it off we hold it in check.

MR. PRATT. Do you spray for it?

MR. WILLARD. No, sir. While it may be a good thing, I have but little confidence in it. I know cutting the knot off is sure, and I prefer to take my chances in that direction. I believe it may be treated, but I have to adopt a system which will work well with men whom I cannot stand over every minute. You can hire muscle, but not brains. I should be afraid, in spraying, the men might overlook some.

If you had been over the Hudson and know how they have lost the best industry they ever had, you would take care to get rid of this black-knot. I can remember the time when they made thousands of dollars a year on their plums. They neglected the black-knot, and it has cleaned out the plum orchards until you cannot find one on the Hudson River.

QUESTION. Do they trouble cherry trees?

MR. WILLARD. Sometimes you will find them on the sour cherries, but not on the sweet. You will find them on the wild cherry.

I think about as bad a thing as we have is the tent caterpillar. We cut out fifteen hundred nests of the tent caterpillar in an orchard where it was supposed to be cleaned out the previous year. Some of my neighbors did not take care of them, and from the breeding places on their farms the caterpillars found their way to my orchard.

MR. WOOD. How far can the spores of the black-knot be carried?

MR. WILLARD. It is said that the spores may be carried two or three miles, especially if it is a damp time.

MR. TAYLOR. Why will not the apricot fruit with us?

MR. WILLARD. I did not know but it would. It is a peculiar fruit. I do not believe there is anything in the tree fruits that is more peculiar than the apricot. We have experimented with them for years and years, but they are of no use to us for commercial purposes.

Mr. JACOB MANNING (of Reading). No use to try to raise them around Boston. When we came to import the Montgannet we found we had some apricots that would give us fruit, and it is as beautiful fruit as you ever saw and is free and exempt from insect life, more so than our plums. The Shense apricot, which was imported from Japan, I think, is the finest fruit in the shape of an apricot that I ever put into my mouth. It has been fruited only three or four years. Mr. Maxwell and myself imported the Montgannet. It has never been disseminated to any great extent. It is worth a trial.

QUESTION. What do you think of the Russian variety?

Mr. WILLARD. I do not think it is worth anything. Don't you be humbugged by any man who attempts to sell you any of those trees.

Mr. MANNING. Twenty years ago, wherever Thomas Meehan saw a rising on the bark of the black-knot, he painted it over with kerosene oil.

Mr. WILLARD. I have taken a hair brush and kerosene and treated them. I can do it with safety, but I cannot hire a man who can do it. I have used linseed oil in the same way.

Mr. UNDERWOOD (of Mt. Tom). The apple which was recommended here is something new to me. I would like to inquire if the Sutton Beauty will keep as well as the Baldwin.

Mr. WILLARD. Nearly as well, and sometimes better. The Baldwin after the first of February is apt to lose, in a measure, its good qualities, and become mealy at the core. The Sutton Beauty is a mild, sub-acid apple. It originated in this State. I should rather have a Greening for pies.

Mr. LYMAN. While at the World's Fair I became very much interested in an apple that I expected before this time would be very popular. It was the Wealthy apple.

Mr. WILLARD. The Wealthy apple had its origin in Minnesota. It was sent out as a winter apple, when in fact it is an early fall apple. It is a great producer, and, unless thinned on the tree, you do not get a nice apple. The September winds are very apt to put them all on the ground, hence it has not become a popular apple.

GEO. CRUICKSHANKS (of Fitchburg). I have known the Sutton Beauty, having lived in a neighboring town for thirty-five years. Having moved onto the place where I now live, sixteen years ago, I had several trees grafted to the Sutton Beauty, and from the crop of 1896 I kept the Sutton Beauty in good eating condition until the second day of August.

Mr. WILLARD. Massachusetts to the front!

Mr. MANNING. As has been said, the Wealthy apple came from Minnesota. It is adapted to that climate because it will stand the winter. It never should have been brought to this State.

Mr. SEARLE. If you were going to set a commercial orchard, would you put in all Sutton Beauty?

Mr. WILLARD. No, sir; I would not put all my eggs in one basket. There is a principle involved there. I would not set an orchard to all of one kind of anything. I would have the Sutton Beauty one of the varieties. This apple has been introduced into the State of New York but a very few years. It will never be an apple that will be disseminated largely except as it is called for. Like the Seckel pear, it has a short, stubby growth. In order to make it profitable at the present low price of trees, nurserymen will grow varieties that will make trees at two or three years of age. This tree has to grow three or four years.

O. B. HADWEN (of Worcester). Perhaps I might add a word of testimony relative to the Sutton Beauty. I have known it for more than fifty years. It originated in the town of Sutton, on the farm of a Mr. Waters, about the year 1847. At the Horticultural Society exhibit the wise committee pronounced it the Hubbardston-Nonesuch, and they carried the day. The man who presented it felt very much disturbed. He brought it for several years, and the committees were in great doubt as to what it was. Finally, when it became a little better known, when it was a little more widely disseminated, it was found that the tree, as well as the apple, was entirely different from the Hubbardston-Nonesuch. The branches of the tree run up almost perpendicularly. It is a great bearer. In 1896 I had trees that would bear ten barrels each. Some fifteen or twenty years ago I sent some

buds to a man by the name of Chase, in the vicinity of Geneva, N. Y., and probably that was among the first of the introduction of this apple into that section.

I think, taking all in all, the productive habit of the tree, the color and the aroma of the fruit and its keeping properties, it will stand well as an orchard fruit for pretty liberal cultivation. The fact is, the tree is one that should be well fed if you want to have good fruit. It bears so much that if the tree is not well fed the fruit will be too small for sale. This year the trees bore well. I have a box in my cellar to-day. I would put in a pretty liberal proportion of Sutton Beauty if I were planting an orchard to-day. I believe it to be one of the best varieties, taking all things into consideration.

Another apple also originated in Worcester County, about twelve miles north of Worcester, called the Palmer. I regard it as one of the finest apples ever produced in the State. Those who know it will give nearly twice as much for it as for the Baldwin. Among forty or more varieties that I have grown (I grow more varieties than I should) I regard the Palmer as the apple par excellence for the season from December to May, both for cooking and for eating. The tree is slender, and you get fruit from it every season. If the tree were as vigorous as the Sutton Beauty or the Baldwin and the more vigorous kinds, I should consider that the Palmer would take the front rank as an orchard tree.

H. D. DANA (of Amherst). The Wealthy apple has been spoken of, and we have had very little experience with it. I have seventeen young trees of that variety; ten came into bearing in 1891. I had some eight barrels in all, and they are a fine looking apple and a fine selling apple; but I noticed the same trouble that Mr. Willard spoke of, and that is that they drop to the ground.

F. J. SMITH (of Amherst). Some of us would like to hear Professor Maynard on this subject of the Sutton Beauty.

Prof. S. T. MAYNARD. It is one of the most beautiful apples we have, and it is in that line that we must work. The New England market is the best market in the world, and the thing that we must do is to produce a nice article, whatever variety we are growing, and then we are pretty sure

to hold the market against importation from the outside. Better quality and better packing will go a great way toward securing the markets.

We have tested the Wealthy apple, and it seems to be a desirable variety. The value of any new variety cannot be determined properly under ten years. There are so many conditions, so many changes in the conditions, and so many new conditions arising, that it would certainly require at least that length of time to satisfy us of its value as a commercial crop.

Mr. DANA. The Mackintosh Red is very handsome, and has a flavor superior to any apple I ever tasted for eating. I would like to know if any one can give us any information about that variety.

Mr. COPELAND. I would say, in regard to the Mackintosh Red, it is as the gentleman said, one of our best apples, but it drops as badly as most any apple that we have. Perhaps Mr. Willard can tell us about it.

Mr. WILLARD. The Mackintosh Red originated near Prescott, in Canada, I think. I was one of the first to set scions in New York. It will do well wherever the Fameuse will do well. The Mackintosh Red has no place with us, although its quality is excellent.

Mr. TUCKER. Is there a remedy for scab?

Mr. WILLARD. Yes, sir; spray with Bordeaux. We have so much to spray that if we can raise a variety without spraying we think we are doing well.

Prof. J. W. CLARK (of North Hadley). In regard to the Wealthy apple, I think those who are near market, where they can ship the apples in every day, are all right, but outside there is no call for an autumn apple of any kind. This apple will keep a long time if put where it is cool. At a distance from market there is no fall apple that I know of that we can make anything out of, except perhaps the Gravenstein.

Mr. NEWHALL. The King apple has been selling for three dollars per barrel.

Mr. WILLARD. The King ought to sell for four dollars, against two dollars for most anything else. There is that amount of difference in the production. To-day you can find no man who would plant the King apple, and for two or

three reasons. The tree is tender, it sets its fruit very scattering over the tree, and the equinoctial storm is very apt to put them all on the ground.

Mr. NEWHALL. What about the Northern Spy?

Mr. WILLARD. It is a standard fruit. It is better in New York than it is in Massachusetts.

The CHAIRMAN. The San José scale has been discussed. I think Professor Fernald has had considerable experience with this scale, and we would like to hear from him.

Professor FERNALD. I was rather shocked this morning to hear the remarks of our speaker, Mr. Hale, and I was glad to hear the attitude taken by the speaker this afternoon, and to hear also that the forenoon speaker coincided with him when we had supposed that he was on the other side. I was glad he explained himself.

We are peculiarly situated here in Massachusetts in regard to this pest, for the reason that there is not a line on our statute books to prevent any infested nursery from outside the State from making this a dumping ground for all the infested stock. Any tree pedler can come in and sell as much of that infested stock as he can get off onto our fruit growers. They are entirely at his mercy. Very few know what the thing is like. Very few can tell it from the other scales. It requires an expert to distinguish between the scales. They cannot all be treated alike. The San José scale gives rise to young continuously; they become so numerous as to destroy the life of the tree. The others have eggs only once a year, and do not multiply so rapidly but that they can be cared for. Cremation is the best thing I know of for the San José scale. My sympathies are drawn out very much for the nurserymen in our State. They cannot send their stock into other States without having it examined, and a certificate that it has been examined by a person who has been appointed by State authority in this State. There is no such person. If I were to examine them, as I have been asked to, it would not stand the law in other States. The nurserymen need protection. They are entitled, I believe, to something in this direction, I wonder that they have not petitioned the Legislature to have an officer appointed to inspect the nurseries.

I do not think the nurserymen are the only ones to be protected. There is many a man who has a fine orchard that is more or less infested. You ought to see the twigs sent to me with questions as to the San José scale. I really begin to think that the orchards of our State are composed of nothing but twigs. It seems as though there should be somebody who has the right and the time to help people in such cases, to go and see what they have.

As to its distribution, I only have a bit of personal knowledge on that matter. We had two apple trees that were infested with the San José scale. It was the first time I had seen it. The trees were found to be infested with what I supposed was the San José scale. To make sure, I sent portions of them to Washington for determination there by the entomologists, and they informed me that my determination was right. These were placed in the greenhouse connected with the insectary. We kept them until late enough in the season for them to hatch. Professor Howard of Washington, who has probably studied this scale more than anybody else in this country, thought they could not endure the climate farther north than what is called the upper Austral region. But we found them right here, and the circumstances were such that we knew they had lived here at least one winter, so we found it could endure our climate. They spread all over the trees, and yet I could not find where they came from. They also spread onto other trees several feet away within the greenhouse. I did not carry them there; the winds did not; my assistants did not; I know of no way that they could have spread except that the flies would light on the trees and these young scales have seized on these flies and been carried by them. If that could be done in the greenhouse, it could be done in an orchard. I believe they are distributed to near-by places by means of insects of different kinds, and that will account for distribution in one way.

I believe we need some legislative help in the restriction of this insect. I have known a number of instances where tree pedlers have brought them in here and sold them to our people, and did not know it.

Mr. HALE. Just one business point. He seems to think

that the Massachusetts nurserymen are at the mercy of other States. I should differ with him. Although you have no law in relation to the scale, I think if the Professor will examine the nursery stock, that his certificate would be taken by any State in the Union. If your nursery men are at all troubled, Brother Willard and I will guarantee that there is no State that will shut them out if you give them a certificate.

PROFESSOR FERNALD. There are only three hundred and sixty-five days in a year. If I teach in the college, if I go down every week and inspect the gypsy moth work and look after the brown-tail moth, how am I to look after the San José scale? The question was as to the value of the certificate. Now, will you please suggest ways and means?

MR. HALE. That is not my business.

MR. WILLARD. In regard to the San José scale, at the time the bill was presented to our Legislature last winter, I saw that we must have a liberal appropriation for carrying on the work, and I went to the ways and means committee and to the finance committee of the Senate and presented the matter to them, and they both thought it was a sort of a fad. I made up my mind that they were not going to take that medicine unless we sweetened it up in some shape. I went home, and, knowing where there was an infested nursery, I secured samples from the trees and put them into such shape that the legislators could see what we had. Trees from the nursery I refer to had been brought into this State. A man told me to-day that he received some two or three years ago. On these samples you could see the scales with the naked eye. On a row of trees we would find five or six or seven trees infested, then we would go along a rod or two where we could not find any with a microscope, and then you would come on to a lot of them again. That was one of the mysterious things. The bird jumped those trees. The Legislature granted us \$10,000. This scale is to me a serious thing. It is not for me to advise what you are to do here.

MR. MANNING. They will be on the shrubs and in the forests.

MR. WILLARD. That is what we do not want. In Long Island, trees that the owner would not have taken a hundred dollars for have been taken up and burned.

Secretary SESSIONS. I have had a little experience in getting appropriations from Legislatures, and I want to advise the nursery men that if they want anything from the Legislature, the petition should come from the men who are suffering. A petition from Professor Fernald and the secretary of the Board would be met by business men with the statement, "These fellows want some more money to spend."

Professor FERNALD. I want to add a word to what Secretary Sessions has stated. It will be of no advantage to me personally to have any such law as has been spoken of. It will increase my labors and my responsibilities, but I am more than willing to help the nursery men and all others interested in the matter. If the matter should be brought before the Legislature, I shall be glad to help in any way I can.

Secretary SESSIONS. I take the same position.

The CHAIRMAN. We have with us a gentleman who for many years was a member of the Board of Agriculture, and I think the audience would like to hear from Mr. Benjamin P. Ware of Marblehead.

Mr. WARE. I came to this meeting with very great interest, as I have for many years. My interest does not lag at all in the work the Board is doing. The subject that has been before us to-day has been of interest to me as a fruit grower on a small scale. I have been very much interested in the subjects that have been brought before us, and in the able manner in which they have been presented. It seems to me that no men could have been brought before us who could have presented the subjects more ably and clearly and so satisfactorily to us who are fruit growers and interested in this business.

Several varieties of apples have been spoken of, and I have listened with a good deal of attention. The Wealthy apple has been grown in Essex County for a number of years, but within the last few years it has grown in importance and in the confidence of the people, and at the last meeting of the trustees of the Essex Agricultural Society it was recommended to be put among the list of apples that are worthy of cultivation in Essex County. Mind you, in Essex County we are not giving premiums on all varieties

of apples. At our last exhibit these apples were large and beautiful, and they attracted the attention of everybody who visited our fair. It has taken the position now in Essex County of an apple worthy of cultivation in that county.

These country gatherings of the State Board of Agriculture, it seems to me, are of very great importance to the farmers of the State. We come together and compare notes one with the other, and we learn very much. What is successful in one locality may be a failure in another, but we go home with a determination in our minds as to what is best for our locality or what is better than we now have.

I want to say a word in regard to the delight I had this morning in visiting our Agricultural College. Perhaps it is known to you that I was a trustee of this institution during its dark days, at the time it was running under an annual debt of ten thousand dollars; when the Legislature had almost come to the determination that not another dollar would they appropriate when it was being spent in that way; and they declared that they would not make an appropriation unless the trustees themselves should become responsible for any debt that might be incurred. I had the honor of being a trustee at that time, and I used my influence, however little or great it might have been, to lift this institution out of that dark condition that was almost death to it. But it survived, and look to-day and see the results. I was delighted to see the great changes that have taken place, the great improvements that have been made; and it seems to me that now we people of Massachusetts, we farmers of Massachusetts, have a plant in this college that is almost perfect in every department. Look at the men who preside over this institution. Look at them individually or collectively. Look at the work they are publishing in bulletins from time to time, and scattering about free to us all. Look at the character of these bulletins and the work that is put before us in the annual report. This work is received as authority all over the United States. I thank God that I have had the pleasure of having been born in Massachusetts and on this soil.

Mr. COPELAND. What would you do for the curl of the peach leaves?

Mr. WILLARD. If you can anticipate it, I would spray with the Bordeaux mixture before the trees leaf out; but I am not sure that we can do that thing. The curl leaf I do not think is to be feared as many do. We have known what it was for years, but we do not get it but once in three or four years. It was about the country last year, and cost the country a good many peaches. Of course there is a difference in varieties. The Elberta is the most seriously affected of any variety I know of. I think a proper spraying with Bordeaux mixture before the leaves come out will prevent it.

Mr. MANNING. Have you seen the fruit of the October Purple plum?

Mr. WILLARD. I have raised it on my own grounds. I believe I was the first man to set a bud.

Mr. MANNING. Some that were raised in California were said to measure seven inches in circumference, and I have raised some equally as large and as fine, and I think a great deal of it.

Adjourned at 4.10.

In the evening, from 7.30 to 9.30 o'clock, a reception was tendered the members of the Board of Agriculture and others attending the meeting, at the chapel of the Massachusetts Agricultural College. The gathering was large and the occasion was a thoroughly enjoyable one.

THE LOVE AND STUDY OF NATURE: A PART OF EDUCATION.*

BY DR. G. STANLEY HALL, PRESIDENT CLARK UNIVERSITY, WORCESTER.

My subject, the love and study of nature, is both very old and very worn. Nature has always been studied and such work has always been approved. Trite and hackneyed as the theme is, however, you will all admit that study is one of the most ennobling occupations of man, that love is the highest sentiment, and that nature in its broadest sense is the largest theme in the world; so that at the outset it must be evident that in the limited time at my disposal I can only touch my vast theme at a few points, and these in only the most general terms.

To begin with, I wish to urge that science, art, literature, religion and human history and society are the five great objects, not only of education, but of human interests. Nearly all of the courses of study in the world have been framed of the material in these departments, and every one of them roots in the love and study of nature.

This may not seem obvious without a little reflection. Let us therefore glance at the history of each of these departments, — first, of science.

I. Astronomy, for instance, which originated with Eudoxus and Hipparchus and was developed by Copernicus, Gallileo and Kepler, is a creation of one of the sublimest of all human interests, that in the heavens above us. From Tycho Brahe, isolating himself on his lonely island for years to devote himself more exclusively to the stars, down to Professor Pickering, in his all-night work in photographing the entire sky on a vast co-operative plan; Professor Holden, at the summit of Mount Hamilton; Mr. Lowell, on Chim-

* Evening lecture.

borazo, trying to settle the vexed problem of canals in Mars; the late Dr. Gould, in his long years of voluntary exile from home in South America; Professor Todd, on his eclipse expeditions, — all are animated by this great love, and the whole science of astronomy was created by its saints, martyrs and hermits smitten, by the great passion to push knowledge to its remotest bounds, that mankind might know something concerning infinite space and its stellar population.

Physics and chemistry, to those who know their history from Roger and Sir Francis Bacon through the period of alchemy and the black arts; botany, which has tempted men into inhospitable lands, sometimes dangerous, and generally involving more or less hardship; biology, consecrated by the service of all sorts and conditions of devotees, from Linnaeus, Lamarck, Cuvier, St. Hilaire and Audubon, down to Darwin, Hagen, and all the Challenger and other expeditions; geography, from Marco Polo to Stanley and Nansen; geology, from Pliny down; anatomy, from Haller and the great anatomists of the seventeenth century, — all these are the creations of men who have abjured an easy life, and have more or less sacrificed the dilettante's love of general knowledge and become specialists with an enthusiasm not all unlike that of Simon Stylites or the Trappists, and who really deserve all the honor which Comte sought to bestow upon them by renaming every day throughout the year from such creators of science, as the Catholic calendar had made each day sacred to the name of some saint selected from the many thousands whose lives constitute that great arsenal of virtue, to the further elaboration of which one Catholic sect, the Bollandists, devotes all its work.

II. Just so nature has in all ages been the muse that has inspired every artist in every line of art. Landscapes from Claude Lorrain and Turner down can be painted in a way to bring out their whole meaning only by those who see with the heart. Architecture, which originated in the forest, from trees and the acanthus; sculpture, which still takes its canons from Greek art, which was closest to nature; poetry, which originated in description and narrative; music, which developed from the songs of birds, the noises of the waves and winds and other sounds of nature, — all suggest, both

by their origin and by their general directive principles, that the best art is that which comes closest to nature, and the best artist is he who remains most natural. No one waxes more eloquent than Ruskin in placing at the head of all creative geniuses those who feel the stars, sky, storms, mountains, flowers, animals, seasons, sunrises and all the varying phenomena of night, day, climate, etc. Professor Vachon, who has just finished the most comprehensive report, in several quarto volumes, of the condition of art in various countries in Europe, and the unknown author of one of the most popular books of recent years, "Rembrandt als Erzieher," agree in two conclusions: first, that the best artists are those who conserve most completely into maturity and old age the sentiments and ideas of youth at its prime; and, secondly, that most of those who approach the top of the ladder of fame in all lines of art are those who have been inspired by the environment in which the most susceptible years of youth were passed, and who have succeeded in expressing most completely its natural responses to the experiences thus suggested.

III. The same law holds in literature, provided we consider only those lands in which it has had an indigenous origin. The contents and substance of the old Aryan literature, as Max Müller has spent his life in showing, are largely faded metaphors, describing dawn, clouds, storm, lightning, personified, and their common phenomena made into allegories of human life. Hercules and William Tell were, as the world knows, simply solar heroes, as the etymology of their names and their achievements show. Diana is the moon, Ahayhu the storm, Vulcan is fire, Jove the sky, etc. The same is true in early Teutonic literature. Brunhilde, Thor, Hagen, are also nature deities. Early French literature shows us primitive animal tales, like Reynard the fox, said to have had no less than a thousand forms and editions, and to have been wrought over in symbolic form and made into material of warfare in long controversies between Catholics and Protestants. Æsop shows another older cycle of similar origin and purport. Animals are said to reflect human life. Take any collection of totems, stories or comparative study of cosmology, and we find the same rule. Among the

earliest products of the Greek mind are the Orphic hymns, some of the best of which we find addressed to night, heaven, ether, echo, earth, sun, stars, clouds, nature, Pan, etc. Read histories of national literature, or of special departments of them, like Veitsch, Biese, Reynolds, Fischer on the influence of the sea on poetry, and the farther back we go, the more evident and all-dominating is the influence of nature.

IV. Religion. Max Müller estimates that, of three thousand Aryan deities, nearly if not every one were originally nature gods; and I venture the assertion that hardly any common or prominent object or department of nature has not somewhere by some people or person been made an object of supreme worship. The Persians and Babylonians were star worshippers, and their only priests were astrologists. The sun and moon were the highest deities for Socrates, and countless temples have been dedicated to their worship. Even Johanna Ambrosius, that amazing German peasant-poet genius, prays in one of her poems that when she dies she may spend eternity in the moon. Parsees worshipped fire, which Heraclites made the supreme principle, of which religion the Zend Avesta is the Bible. The East Indians held clouds, storms, weather and lightning to be divine. Many savages worship water, which Thales thought the best of all revelations of deity. Not only savages, but half-civilized peoples, have been fetish worshippers, and bow down in religious awe before stones and other inanimate objects used as charms and amulets, as Mr. Condar has shown in his fascinating book, entitled "Heth and Moab." Flower and plant oracles in popular superstition are remnants of a wide religious cult, which associated plants and planets for both medical and sacred uses by the doctrine of signatures. The Druids, as the name indicates, were tree worshippers, and for them as for no others the groves were God's first temples. Nearly all the primitive population of America were totem worshippers, and held that beasts and birds were incarnations of great heroes of the past, whose souls had entered their bodies by transmigration. Serpent worship, as Mr. Ferguson has well proven, at one time spread nearly all over the world. Confucius and the Chinese and many polytheists worship human ancestors

or great men, perhaps apotheosized into demigods. Pantheism, the more or less conscious religion of many of the most cultivated minds to-day, is the deification of nature; and we are often told that the unity of mind and faith we call monotheism, the achievement of which was one of the greatest labors of the human soul, could never have been wrought out but for the influence of the all-encompassing blue void of heaven, perhaps pierced by some Sinai or other sacred mountain. Hymn books of many faiths have been studied that show us how dominant natural objects and phenomena have been in shaping the religious consciousness of the world, and how inconceivably different all would have been but for the symbolism involved in the score or two of those most favorite.

V. Man is the bright consummate flower of nature. In our growth from childhood or from the earliest prenatal beginning, each of us repeats in his own individual life the entire history of life since it began upon this globe. You and I have practically been plants or protophytes, protozoan, metazoan and all the rest, recapitulating each stage. The human brain, through which all revelations have come, is the only mouthpiece of the Divine in the world; so that man, who, on the whole, stands at the summit of nature, has not only been the chief subject of interest to himself, according to the well-known dictum of Pope, that the highest study of mankind is man, but philosophers have assured us that we cannot possibly think too highly of ourselves. Human personality is naturally, therefore, our organ of apperceiving deity; and even yet it is regarded in some localities as a little heterodox to even raise the question whether or not God may be something higher than personality, even though we agree that he can be nothing lower. This is the stand-point from which all the bases of anthropological studies are made; and, if the burden of the Bibles rolled out of the great heart of nature, as Emerson has told us, far more has man emerged from the same source, and is himself the highest of all revelations. We may say, to parody the old apothegm of the relations between the Old and New Testaments, that in nature man lay concealed and in man nature stands revealed. His existence and his intelligence raise all things to a higher

potence, in the sense in which Schelling was fond of using that term, because he is a microcosm, and to know all that is in man will be to know all that is in his universe.

From these rough and brief characterizations we may see that, in the larger sense of that mighty word, in nature about all human interests are involved, and that the love and study of it might almost be made the supreme duty and end of human existence.

Let us now pass to a very different part of our theme, and show how, in its early stages, the development of childhood passes through all these stages of love and interest. We have collected many hundreds of cases where children gather stones, knots, bits of metal, pottery, wood, bone, shells, leather, rags and scores of other inanimate things, endow them with a rudimentary kind of sensation, keep smooth, bright or pretty colored stones in cotton, try to keep them warm, carry them in their pocket or otherwise about their person, and even talk or invent experiences or myths about them, and are essentially fetish worshippers in all that that term implies. We may have done thus more or less in our early years; but memory rarely preserves traces of these experiences, which, indeed, have to be scored away to make room for higher and larger mental content. This is going on often with our own children or those about us, unnoticed by even the fondest parents; and is, indeed, concealed by most children in civilized lands, who are early haunted by the dim presentiment of a future stand-point. Again, we have a large collection of spontaneous conversations with or invocations of prayers to the sun, particularly to the moon, by American children, who illustrate the once widespread astrological consciousness. Many see the faces of just dead friends, parents, God, the Virgin Mary, Christ, etc., in the moon. They often make it an external conscience, believing that is recedes further into the sky or grows either small or dim when they are bad, it is repelled, ashamed, hiding behind clouds for shame, or tearful of their wrong-doings, or comes nearer, getting larger, brighter if they are good, and in rare cases even speaking commendations of their acts. So, too, flowers have a language all their own. The rose speaks of love, the violet of modesty, the lily of kingly beauty, the

poppy of sleep, the ladies' slipper, honeysuckle, dewdrop, harebell, tulip, marigold, dandelion, hollyhock, jessamine, hyacinth, clover, buttercup, daisy, — all suggest at least, if we turn to their etymologies, how warm and close about the human heart flowers have always lain. They have moral qualities, and illustrate psychological characteristics, brighten the earth and therefore the heart of man. Their fragrance suggests incense, the miracle of their relations to birds and insects and their perfumes are the creators of special sentiments, and the best of all language of some and reflections of others. The seer who plucked the flower from the crannied wall realized that, could he but know what it was, root and all, leaf and all, he would know what God and man were. While the human clodhopper is he for whom, as for Peter Bell, the cowslip by the river's brim, a yellow cowslip is to him, and it is nothing more. The great kindergarten apostle lay one day, he knew not how long, gazing into the calyx of a yellow flower with black spots, and arose from his hypnotism by it a new man. Flower lore reflects all this childish stage, and teaches us how to begin instruction in this field, rather than, as is often done, to dull the apprehension and spontaneous childish interest by the technical methods and names of adult botany. For the child the trees literally talk, as their leaves murmur in the wind. They hear and repeat the words by which they call the birds to alight in them, eat their fruit, build their nests in them, sing, scold, invite them to climb to their branches, etc. It is painfully cruel to trim trees or shrubs, and often punishment to flowers to pluck them, and murder to pull them up. All this animism is a placenta by which nascent interest in nature is nourished and stimulated to grow toward maturity. While great care to furnish abundant pabulum in this direction should be taken, interference is mutilation of the budding soul.

So, too, with animals. The child's soul sees no chasm between pets and other human beings. The dog, cat, horse, and often all the rest of the animals within its ken, perceive, feel and think as the child does; are responsive to all its intentions and endeavors, and speak a language essentially different, but sometimes with plenty of human words in it; have souls that go to the animal if not to the human heaven;

are perhaps even more companionable than parents or play-mates ; love, hate, fear, feel revenge, are good or naughty, quick or stupid to learn or understand, tired like the doll when the child is tired, eat, sleep and walk like and sometimes with their little human owners or companions, love to be dressed, to be carried to ride, to have their toilets carefully made, to be decorated with ornaments, etc. Indeed, we might almost define the animal world as consisting of human qualities broken up and widely scattered throughout nature, and having their highest utility in teaching the child psychology by a true pedagogical method. The pig, to a child who knows its habits and what piggishness means, is a symbol of impetuous greed and gross selfishness not only in eating, but also in other matters of filth and untidiness, which gives the child with this familiarity a better conception and a truer reaction to all that these qualities mean in the world of man. To say, of a woman, She is a butterfly or a peacock, describes traits which it would take a whole chapter to explain to one who was not familiar with these forms of animal life. In the same way, the goose, the fox, the eel, the lion, bulls and bears, the eagle, the dove, the jay, the cuckoo, the hawk, the pelican, the crow, the serpent, the gazelle, the cormorant, the badger, wolf, tiger, elephant, alligator, fish, chrysalis and its metamorphoses, the bee, ant, wasp, the sloth, insects, the ape, hibernation, migration, nest-building and scores of others are psychological categories or qualities, embodied and exaggerated so that we see them writ large and taught object-lesson-wise to those who live at a stage when character is being moulded and influenced pro or con in each of these directions.

We might add a long list of more or less mythic animals or popular misconceptions of animal traits. The leviathan, the phoenix, the albatross, the tadpole, the frog, the centaur, the children's fancy in creating impossible new animals, is almost as fecund as nature herself. Therefore we plead for menageries, for collections of animals in every public park, pets, a familiarity with stables, school museums of stuffed specimens, the flora and fauna of the neighborhood in every school-house, to say nothing of instruction in every school concerning insects, birds and animals which are noxious, and those which are helpful to vegetation, fruit and agriculture

generally. The story of the gypsy moth; the phylloxera; the caterpillar; the tobacco worm; the life-history and habits of other parasites in the bark or on the leaf, in seed or pulp; the marvellous habits of the botfly; the angle worm, through whose body all our vegetable mould has so often passed; the common house fly, with its interesting and less ephemeral story than we would have thought; the grub; the wire worm; moth and bat; the food fishes; weeds; sorghum; ginseng; grasses; potato beetle; hemp; peach-tree borer; the apple aphid; the tent makers; and many other fascinating living creatures which have been so carefully studied of late in our agricultural colleges, — have a moral as well as a scientific interest to childhood, and make a kind of knowledge which has an educational to say nothing of an economic value, and which must be ranked as one of the very highest.

Many animals excel man in certain qualities of sensation, instinct and physical development; so that even the adult is looking up and studying higher qualities than his own, in learning of animals and their ways. They are not only our older brothers, but are fit in some respects to be our teachers. Man's supremacy in the world consists in the fact that the qualities in which he excels animals are more numerous than those in which he is inferior to them, and that certain of these qualities are developed to a high and perhaps even excessive degree. The unfoldment of these, however, comes late in his own development, and those which distinguish him from animals are added last; so that arrest in critical later stages of adolescent development condemns him to pass through life deficient in just those traits which are most characteristically human. That is why, as Doederlein, Mehnert, E. Boas and others have lately shown, those who marry early, before complete maturity, transmit only qualities that they themselves inherited, while those who do so later add an element, infinitesimal though it may be, of individual contribution to the phyletic development of the race; and explains why early sexual maturity is a bad sign for the advancement of the species. Children thus in their incomplete stage of development are nearer the animals in some respects than they are to adults; and there is in this direction a rich but undiscovered silo of educa-

tional possibilities which heredity has stored up, which, when explored and utilized to its full extent, will reveal, in my judgment, pedagogic possibilities now undreamed of. The whole history of the domestication of the two or three hundred animal species has largely been the product of this sympathy with the brute mind and life; and if it be true, as is claimed, that most of all these animals have been trained by woman, it is only another illustration of the fact that her life and mind are more generic than that of man. Even the instinctive fear of animals, insects, etc., often harmless, shows not only how old and close the relation between man and beast has been in the past, despite the great evolutionary chasm caused by the loss of the whole series of missing links, but supplies the other chief ingredient of interest, which is most intense where fear and the love which casts it out are battling for supremacy. This stratum is one of the very richest layers in paleopsychic development, and its outcrops in the many varied zoölotries of savage life which show its strength constitute one of the most interesting illustrations of the way in which the stages of a child's development repeat those through which the race has passed.

Inadequate as are the partial presentations of this momentous theme, they at least give us the stand-point from which we can pass at once to the chief practical application which I wish to make of the modern doctrine of nature. It is that nature in this broad conception of the term includes the fundamental subject-matter of all education, and that language study is accessory and essentially only expressive of it; that mathematics is simply the most accurate description of facts and laws in nature; and that every technical or methodic department of education is entirely subordinate and accessory as a means to the one great end of knowing the world in which we live. Consider for a moment to what an extent the school has both perverted and inverted the order of growth. Astronomy, perhaps the oldest science, was first of all a religion, and its early development was the product of pure intellectual curiosity. The study of celestial objects and phenomena were all associated with man's conception of the future home of the soul. Later, the practical side, useful in navigation and in establishing topo-

graphical location, etc., came in. But now astronomical research is motivated by as pure and scientific a passion for knowledge for its own sake as can be found; for a great astronomer has well said, in substance, that not one of the marvellous discoveries in the new astronomy of the present century has had the slightest practical value, according to any of the current utilitarian uses of that word. We, however, now allow all the earliest fresh interest of childhood in the physical heavens to go to waste. Astronomy is rarely taught in grammar grades, high schools, or even colleges. Even the latter formerly made the observatory of the early part of this century, in the days of Albert Hopkins, Mitchell and Burret, simply a means of uplifting of the soul. Now the great observatories often do no teaching even to a few experts; and the high schools that introduce this topic begin it by accurate determinations of noon marks, or superfine measurements of positions and time determinations, of tides and eclipses, bringing the mathematical side, which came so late in race development, to the front, and entirely ignoring the fascinating historical development of the subject from Hesiod down, — and that despite all the popular text-books which are at hand, — Ball, Peck, Langley, Serviss, Young, Proctor, and perhaps we might even add Verne.

Again, meteorology begins in cloud fancies. Children, like savages, see in cloud forms and colors everything with which they are familiar enlarged and glorified in the sky. God, Jack Frost, Santa Claus, all kinds of judgment day scenes, regal robes, festoons of ribbons, flags, battles, the forms of heroes and demigods, the faces of just dead friends, fairies, maps, etc., are seen and watched with breathless eagerness and interest by children in this great school, which has had more than any other to do in creating the imagination of the human race, as well as its mythology, and given us gods of thunder and lightning, built rainbow bridges to heaven, and generated a whole body of weather lore and metaphors which still dominates human moods, so that the weather curve affects even crime and school discipline. The poetry, and, indeed, even the crystalography of snow-flakes; the music of the winds and all the phenomena of dawn and evening, — all these find little place in school text-books in

meteorology, but instead the juvenile mind is introduced to this subject by the Latin names of clouds, the dynamics of the air, the laws of trade winds, the chemico-physics of precipitation and tedious measurements of rainfall, the composition and pressure of the air, measuring refraction, the physics of cyclones, the equations of pressure, laws of the transmission and absorption of heat, the geological origin of atmosphere, with perhaps practical rules for ventilation. These matters are of course of the greatest scientific importance, and have their place; but my contention is that they should come late, and not first, in this field of education. Here, as everywhere, the technical should be preceded and long preceded by the human interest-generating studies out of which these grew, and without this propædæutic they have no depth of soil in which to strike their roots.

Again, in physics, which we have now forced into unnatural precedence over subjects that deal with life, especially in high school and college preparation, the natural interest in steam engines, batteries, color tops and the countless mechanical toys which illustrate nearly every great principle and awaken a deep and spontaneous interest in the boy mind, have been forced into the background by precocious insistence upon the exact, if not even the mathematical, elements at the very outset. Even the general conceptions of vortexes, ether, vibrations and force in general, and speculations on ether and perpetual motion, and other highly theoretic problems, have more interest in them and appeal to the scientific imagination far more strongly than the accurate studies of the pendulum, lever, the determinations of specific heat, measurements of light intensity, the mathematics of reflection and refraction, etc., which constitute the material of most of our elementary text-books in physics, — although it must be admitted that in this science the evil is not so bad, and there seems to be slow but sure progress in the right direction.

Almost the same may be said of chemistry. There is a wealth of historical matter in this science, beginning with alchemy, which is calculated to develop interest, but which is too often neglected even in colleges. Boys are interested in atoms and molecules, and can follow the teacher to the very frontier of speculative knowledge, where the adult

expert is himself a child, better than they can at the very beginning grapple with the subtle laws of valencies, or be forced to speak and write at once in the new and wonderful language of chemical symbols.

Perhaps the worst pedagogic sin against the laws of psychogenesis is now perpetrated in the way in which botany and zoölogy is begun. Here often we still have first of all classification and Latin names, which came so late in the development of science, and yet now, since evolution has been so revolutionary, serve only to set biological housekeeping in order and get ready for work. It is so fascinating to the adult mind to begin logically with the cell or with lowest forms of life, the latter sometimes inaccessible, the former never seen save through a microscope, and to proceed up the scale of development by complexity in a way which brings last those things which are most familiar, instead of starting, as old naturalists did, with the simple, breezy, out-of-door and undeflowered love of nature. A comprehensive consensus shows that children on the average know and love best in order, among the flowers, first the rose, then the violet, daisy, buttercup, lily; of garden growths, first the potato, then corn, tomato, bean, radish; of insects, first the bee, then the butterfly, ant, fly, mosquito, spider, wasp, grasshopper, beetle; of birds, the robin, then the sparrow, canary, bluebird, blackbird, parrot, hawk, swallow, crow, eagle, pigeon; of domestic animals, the order is the dog, cat, horse, hog, sheep, mouse; of wild animals, the elephant, lion, tiger, bear, monkey, wolf, and so on. This shows us where interest begins, is deepest and strongest; and when we turn to the folklore of plants and animals, we find something very like the same order in the profusion of myths, songs, poetic names, etc. Flowers are a kind of language of the heart, and are loved themselves and express human affection. I collected once twenty-one poems on the daisy, and no doubt as many poems, fables perhaps with a moral, proverbs, etc., could be collected of many other objects in the above list. The mythic trees, from those in Eden to the sacred oak of Dedona, and the fairy and transmigration tales, and especially the studies of fertilization and of the life-history and instinct of animals, which can be

made so fascinating as introductions to the study of animate nature, suggest to us where these interests strike their roots deepest and where alone pedagogic art can find or generate the zest that can generate momentum enough to conquer the technique of histological methods and technical nomenclature. Save in the feeble and often infantile beginnings here and there made in the kindergarten grades, the true methods in this field are at present, we must candidly admit, as yet undeveloped. This is a field ripe for the harvest of pedagogical research and investigation; and I know of few lines so ripe for epoch making, greatly needed and inevitable reconstruction of present methods, where a committee of ten, if indeed the country can supply that number of the competent, should seek a consensus of the best that recent scientific developments of pedagogic art and psychogenetical results could now supply.

Again, geology is one of the greatest triumphs of the human mind. It gives in outline, although with many gaps, the development-history of the world in which we live; and its educational value, not only from the importance of its body of facts, but as logical discipline, is perhaps second to no science. But mineralogy, with its technical nomenclature and detailed study of the forms of crystals, and especially petrography, while perhaps the best method of logical approach, is the worst pedagogically. Rather the selected topics from the life of primitive and perhaps cave-dwelling man; the extinct animals and plants; the landscape in the period of coral formation; emergence and subsidence; reversing the order of time and always beginning with subjects of human interest and irradiating to the vegetable and then the inanimate world, and back towards primeval nebulae, with paleontology always preceding lithology, — would be the order of psychic evolution.

I have no time or space here for details concerning these or other departments of nature study. My purpose is solely to show the difference between the genetic or pedagogic and the logical method. The latter is essentially for the adult mind, and a great error of teachers and curricula has been that these scholastic ways of approach have been substituted for those which conform to the natural laws of growth of the

intelligence, interest and power of comprehension. I cannot forbear, however, to say that geography, as now taught and administered in our school text-books, illustrates the climax of all this confusion. To have begun with the world of Homer and a few primitive maps; to have widened to the universe of Dante, as pictured in Rosetti's charming introduction; with some account of the labor of soul that led to the epoch of discovery introduced by Columbus; the warfare of science and religion in the days of Gallileo; selected themes from anthropology; something about sacred mountains; the great mediæval highways; accounts of surveys, — would have been better, as would even the method that begins with the school-room, yard, street and town, than the modern limbo of boundaries, capitals, mud maps, a farrago of scraps of astronomy, zoölogy, mining, agriculture, political divisions, botany, geology, races of men, history, etc., which make modern school geography the most anti-scientific unpedagogical of all school topics. These subjects have little or no very obvious connection with each other, from the stand-point of nascent periods, some belong earlier and some later, and the whole could come anywhere or nowhere. Most of it has to be memorized with the items in arbitrary connection, and it is a kind of gehenna or place of skulls in the economy of scientific housekeeping. It is the science of the poor in spirit and the feeble in heart. Those who go on through college have the work all over in different and more logical connections, so that, if it were justified, nothing would better illustrate the falsity of the now oft-quoted but misleading principle, that the same studies should have the same manner of approach, whether education ends with the minimum of legal requirements in the grammar school or proceeds to a degree. I once took a prize in school for bounding every State in the Union; but now, although I have visited most of them, I probably could not accurately bound a quarter of them, and nevertheless I manage to lead a life not particularly handicapped by intellectual penury, which is regarded by my friends as, on the whole, that of one who might pass for an educated man.

Geography is the great obstacle to-day in the way of placing the study of nature on a sound pedagogic basis. It

is an amorphous relic of pre-scientific days in education, the text-book maker's pet and the true pedagogue's abomination. If we could reduce it to a fourth or a tenth of its present time and dimensions, and substitute the rudiments of the leading sciences of which it is a kind of hash, resembling life only as an unlinked sausage resembles an organic and living snake, the efficiency of our entire school system would be greatly enhanced. Such a change can of course come only slowly; strongholds of prejudice rarely capitulate at once, but are gradually worn away by the fresh currents of thought and knowledge that are now acquiring more and more momentum. Compare the scope of a full-blown modern geography, with all its canvas of maps, its photographs of cereals, mines, cars, tables of population, animals, geological scenes, barbaric costumes, fishing and hunting, fine public buildings, ships, huts, savage wagons, sculptured heads, savage customs, happy families of beasts, birds and insects, extracts from census maps, and with chips from, as I estimate it, about seven to ten different sciences, with the modest field of work laid down by the professors of geography in the few foreign universities that enjoy that admirable luxury, or the field which the Royal Geographical Society proposes to itself, and we shall realize what a fungoid, nondescript and amorphous parasite threatens the health and well-being of our school system.

As Turkey is sometimes called the sick man of Europe, so geography is the sick subject of our curriculum, and needs doctoring. Turkey is a bit of Asia and Africa which erupted into another continent. It represents a faith once so strong as to threaten to overrun the West, but is now the reduced relic of mediævalism. Just so geography in its old form, cosmology, included almost the entire field now occupied by the sciences that deal with nature. Its frequent definition, — a description of the earth — including, of course, the air above and the mines beneath, and not limited to a mathematical surface, includes almost everything that can ever be of interest to man. The special sciences have split off from it somewhat, as the different humanistic branches have gradually split off from philosophy or geology yet earlier. Again, our text-books in geography in recent

decades, as an inspection shows, are mostly written by men who would not be recognized as members of any geographical society, and many of whom lack a collegiate education. The same is true of a number of those who are most prominent representatives or advocates of its methods. So that the doctors of our sick men are not recognized by the general school. In his comprehensive memoir upon the subject, Mr. Scott Keltie, among two hundred and twenty-nine text-books in geography, mentions only three American ones. Geography, while it has had able representatives in special departments of it in this country, is the favorite tumbling ground for the half-educated or uneducated, and has never felt those stimulating influences that are always working from the university departments downward, but has been left almost entirely to be shaped by the school-master and the publisher. It has nearly all the defects of popularized science, without the saving merits of the latter, — of having been made by experts.

I would by no means advocate the entire abolition of geography from the school courses, but I would not only greatly reduce the text-books and time, but put the work much later, and teach most of the matter now included in it in the high school, in proper scientific connection, — part of it with history, part with astronomy, part with geology, part with natural history, etc., — the elements of all of these to be thus made room for at the expense of their common enemy. This in a way would respect and not actually injure the unity of the child's mind. I do not expect these changes to be sudden. The methods and text-books of teaching nature which I would substitute are not yet sufficiently perfected, but we do now know, from the study of the child's mind and the order of the development of both its interests and its powers, that all these are disregarded and sometimes outraged by the modern American school geographies. I hope the time will come when, in the new university developments impending, we can have enough professors of geography among them all, by the methods of the division of labor, the essential departments properly included under this name, and this will help to reduce the hypertrophy and congestion and chaos from which the schools are now suffer-

ing. Indeed, I think the students of childhood will before long be ready with a recipe for making these text-books and courses that will obviate many of these evils; but I have space here only to characterize what is now, since theology has withdrawn most of her objections to science teaching, its next most formidable and hereditary foe.

To conclude, nature has a practical aspect; but even agriculturists should not limit their interest in her phenomena to the economic side. The harm or good done to crops by insects, birds and animals has been a very great stimulus to the study of their instincts and breeding habits; and the utilitarian knowledge thus acquired is of very high importance, but it is not all. There is another higher and purely scientific interest, prompted by man's undying passion to know. This intellectual interest has given us the best, fullest and most accurate knowledge we have of embryology, classification and every other factor which makes the great body of natural science, which is one of the most precious achievements of the race thus far. This impulse has given us evolution, which, whether as an increase of mental economy by affording a wider range of knowledge with less effort, or as rebasing all our fundamental conceptions of life, love, reproduction and disease, is, with the doctrine of the conservation of energy, the great scientific achievement of this century, which makes it now impossible for a specialist to be narrow.

But there is a third factor. Myth has always been the matrix of science. Indeed, it has been more, — it has been the very yolk itself to be transformed. Myth is the juvenile form of science; in clumsy trope children have a special set of intellectual milk teeth, very variable in size and some of them never lost, especially adapted for the animistic stage of mental nutrition and development. In the largest sense of the words, myth and science, neither can entirely expel the other. The mechanical accurate view of things may predominate at one time or in some minds, and the poetic or spiritual at other times or in other minds; but one criterion of each is, how much of the other it can carry and vitalize. The human stand-point for the study of nature is not only the best introduction to the religious view of the world, but

the philosophy ; and leads in its higher developments at least to a kind of Christian pantheism that every religion must admit is good as far as it goes. Science must purge myth of its fetishism and idolatry, and myth must keep science alive with warm human interests.

In some sections of our country it would almost seem that nature work is declining relatively to its former prominence, and is certainly far less central than it should be. City life is unfavorable to fresh contact with nature at very many points, and adequate illustrative material is hard to get ; so that teachers sometimes give up in despair, because these branches cannot be presented according to modern object methods. Moreover, city children are, as abundant records show, amazingly ignorant of the commonest phenomena of nature. On the other hand, there has been recent progress which we must all hail with great joy. Religion and science are each giving abundant signs that the long warfare between them is drawing to a close. This means an immense economy of energy, hitherto wasted in conflict between two great human interests, neither of which can satisfactorily flourish without the other. Many do not realize how far we have advanced since the days of Huxley's greatest bitterness, Tyndall's prayer gage, and the crass materialism of Buechner and Moleschott. Faith and science cannot be opposed. The great Heart of the universe does not do one thing in his works and say another in his word. The attitude of young scientific students toward religion is growing more and more favorable. Clergymen are more interested in science, and the plea that it must be an element in all theological training and also in the Sunday-school is now being heard. We also hear fewer denunciations of "science falsely so called" in the pulpit, and the same student now often believes in and is interested in Genesis and in geology. The mystery and lawfulness of nature everywhere inclines to that religious awe, reverence and dependence which Schleiermacher well makes the basis of religion in the soul. The same great biologos that presided over the formation of the amœba, jelly fish and the ascending orders of vertebrate life, up to man, is not yet adequately expressed, but has in it the momentum of far higher evolution. The super man that is to be and above

all the Jesus of life and ideal, which is at the very top of the organic evolutionary series, the highest branch of the great family tree of which we and even the animals beneath us are lower twigs, shows us toward what lofty goal the best developmental influences in the world are tending.

We read of the venerable Bæda gazing through his rude astronomic tube, and pausing to write a *Magnificat* or a *Gloria in Excelsis*; of St. Francis D'Assisi addressing stars, flowers and worms as his brothers and sisters; we see the order and perfect structure of the lowest and most repulsive things, and realize that nature is a veil; as the term indicates, that it is pregnant with the about-to-be; and when we realize how all things seem to cry out for a higher explanation, and strain our eyes to see through the azure, our heart sings the ancient and only song of Horus, "Hush, all hush." There is no matter that is dead or inert. What seems so is an accident, perhaps merely of temperature, or we know not what. This world is dynamic, and made of pure force, and that is spiritual. Of her most repulsive aspects we might use the language which that quaint and recent English genius poet applied to his mistress, who was homely, but with every charm of character and spirit, when he cries, "I cannot see thy countenance, love, for thy soul."

There surely is a renaissance, a revival of the love of nature abroad in the world to-day. The book stores show it in numberless new books, with large sales, on ferns, mushrooms, birds and stars, which the people buy and read. Magazines, lecture courses, the vast body of new popular science extension work show the same thing; although there are many mucker or Philistine souls whose hearts are still hardened against the knocking of the still, small, pleading voice of this holy spirit. I well remember how the faithful country pastor of my youth, at the close of his revival sermons, used to say, pointing a long finger in turn toward almost all of us, "And now, do you, and you, really love God; and, if not, will you now turn from the error of your ways before it is too late?" And I say to you, with no less solemn sanction and no less unction, Do you each now really love nature in this day when her holy

spirit is so abundantly poured out on us, or are you still aliens and exiles from her great repose? If so, come, taste and see that she is of all things the purest, noblest, greatest and truest. She can console, inspire and reveal. She is the great all-mother from whose bosom we sprung, and to which at least all that is mortal of us will return. In affliction, in calamity, when conscious purpose and endeavor fail, we can sink back into her everlasting arms; and when creeds and philosophies weaken or fade, we know that if our bark sink it is to a larger sea. Science now tells us that there is no void, but that infinite space is full of ethereal energy. We know that wherever on this earth life is possible, it exists; and that some great power behind and under all causes every species to multiply, sometimes with amazing rapidity, so that, were this fecund energy unchecked by selective and other influences, a single species would literally fill the world. Science has taught us, too, that there is no chaos, but everywhere there is law; and the slow evolution of sex and parenthood shows us that at the bottom and top of all is love. The highest and latest product of all is man, and the supreme function of all that we call the environment throughout this complex magazine of forces and influences is the intuition of the soul, as if everything existed to bring these to their fullest maturity. Thus childhood and youth at their best and in their full glory are the consummate flowers of nature, and more worthy than anything else on earth of love, reverence and devoted service. Unity with nature is the glory of childhood, and unity with nature and with childhood is the glory of fatherhood and motherhood.

THIRD DAY.

The meeting was called to order at 10.30 A.M. by Secretary SESSIONS, who said: The hour has arrived for the lecture of the morning. By the instruction of the vice-presidents and the executive committee, I am to invite Mr. W. A. KILBOURN of South Lancaster to preside this morning.

Mr. KILBOURN. It gives me pleasure to take this position, and, on this last day of the most successful and enjoyable winter meeting of the Board of Agriculture which it has been my pleasure to attend, to be able to present to you this subject, which is of great importance to our farming communities, and to introduce to you a gentleman whose experience and position will enable him to give you valuable instruction. I take pleasure in introducing to you the director of the Vermont Agricultural Experiment Station, Prof. J. L. HILLS, who will address you on the subject "How can New England compete with the west in dairying?"

HOW CAN NEW ENGLAND COMPETE WITH THE WEST IN DAIRYING?

BY PROF. J. L. HILLS, BURLINGTON, VT.

May I not be forgiven, if, for a minute before we take up the topic of the morning, I express my pleasure at this opportunity of greeting the farmers of my native State. I am doubly gratified that this meeting has occurred in the town where my young ideas were first taught to shoot at the target of agricultural knowledge and investigation. I am glad, moreover, on this occasion publicly to acknowledge the debt I owe to the Massachusetts Agricultural College for the training and the nurture it gave me, to lay at the feet of my alma mater the offering of what little good there may have been in me and in my work in agricultural teaching and research. And, finally, as dean of the agricultural department of the University of Vermont and State Agricultural College, I am proud to bring its greetings and best wishes to its sister institution.

I have approached the consideration of the subject of western competition in dairying with some diffidence, because my life work has lain along lines which have not enabled me to take a comprehensive view of subjects dealing intimately with market conditions. To cover such a subject broadly, one needs to occupy the several stand-points of producer, commission man and consumer. I have read, studied, thought, conversed, experimented more or less on the general subject and on allied topics, in connection with college, dairy school, farm institute and experiment station work, but almost always from the stand-point of the producer. If, then, my ideas are one-sided, if I lay too much stress on production, if my errors of omission are only less glaring than those of commission, I beg that my hearers will not hesitate to supply the deficiencies in the discussion which I

trust will follow the close of the address. Pray be free to debate, to controvert, to differ at your heart's content; thus will the grain be threshed from the straw.

Lies were classified once by somebody as white lies, black lies and statistics. Again, it has been said that, while "figgers don't lie, some liars figger." Notwithstanding these strictures, I am going to risk calling your attention for a moment to certain statistics showing the wonderful increase in the dairy industry in the west during recent years and the relatively small volume of New England's dairy interests. The only data at all adequate to the purpose are given in the census of 1890, and refer on the one hand to the six New England States, and on the other to the twelve northern central States, — Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska and Kansas, — all of which are now largely engaged in dairy husbandry.

Cows. — There were in 1890 ten times as many cows in the northern central States as in the New England States (New England, 822,001; northern central States, 8,240,999). During the forty years from 1850 to 1890 the number of cows in New England increased 35 per cent, while in the same time the number in the northern central States was multiplied 527 per cent (New England, 1850, 608,219; 1890, 822,001; northern central States, 1850, 1,564,219; 1890, 8,240,999). Indeed, the increase between 1880 and 1890 in the number of cows kept in the northern central States was 53 per cent, as against 29 per cent increase in forty years in the New England States. This increase was three and one-half times the total number of cows now held in New England (northern central States, 1880, 5,402,081; 1890, 8,240,999).

Milk. — Eight times as much milk was made in 1890 in the northern central States as in the New England States (New England, 338,911,582 gallons; northern central States, 2,719,414,765 gallons).

Butter. — Eight and one-half times as much butter was made in the northern central States in 1890 as in the New England States (New England, 77,240,024 pounds; northern central States, 650,551,588 pounds).

Cheese. — Twelve times as much cheese was made in 1890 in the northern central States as in the New England States (New England, 9,107,034 pounds; northern central States, 110,225,861 pounds).

The butter product in the northern central States during the census year was $54\frac{1}{2}$ per cent of the total production of the entire country, while that of the New England States was but $6\frac{1}{2}$ per cent. Their respective proportions of the cheese production were $43\frac{1}{2}$ and $3\frac{1}{2}$ per cent and of the milk production 52 and $6\frac{1}{2}$ per cent.

If, however, we turn to the data showing the number of cows and the production per square mile, we find that the difference between the western States and the New England States in this respect is purely one of area. New England is outclassed because of its small expanse of territory. We find Vermont, Massachusetts, Rhode Island and Connecticut ranking among the forty-eight States and Territories 4th, 7th, 5th and 3d in the density of cow population, 1st, 9th, 13th and 4th in butter production per square mile, and 3d, 15th, 5th and 11th in cheese production per square mile. Only two of the twelve northern central States rank less than 10th in density of cow population, but four out of twelve rank less than 10th in butter production per square mile, and but five out of twelve less than 10th in cheese production per square mile.

The figures which I have instanced during the last few minutes are doubtless not new to this audience. They serve, however, to show that the volume of New England's dairy production in proportion to her area compared favorably with that of the west in 1890. We should remember, however, that dairying has taken great strides in the Dakotas, Kansas, Nebraska and Minnesota since 1890, that there has been but relatively small increase in the volume of New England's business in this respect, and that the figures given are low of truth for the conditions of to-day. Its dairying, therefore, stands in danger of being overwhelmed by sheer force of numbers.

To all intents and purposes, New England sells its dairy products at home only. Some whole milk goes to New York from Connecticut and western Massachusetts; perhaps some

butter from the lower States finds its way to New York. These, however, cut but a small figure in that market. New England butter and cheese as special classes, worthy of special quotations, have long since disappeared as factors of trade outside of the limits of the six States. New England of itself, however, is a great and ample market, but more and more each year the goods of the west are elbowing the home-made product out of its own place. Every year the proportion of western goods sold in the Boston markets increases, while that of eastern make diminishes. Here is where the shoe pinches. This is why, of all the important matters connected with dairying, your secretary deemed this the burning dairy question of the day. This is why, moreover, he broadened the topic to cover New England, and did not limit it to the Bay State only. We feel this competition on our Vermont hillsides, as do you in the Connecticut valley. It behooves us, then, as dairymen, to consider carefully any and every legitimate means which may be suggested looking towards the wider use of eastern dairy products.

A general, in planning a campaign, seeks to learn the nature, extent, location and disposition of the enemy's forces, and the advantages he possesses; he measures against them his own resources; and finally studies wherein he may lessen his opponent's chances of battle, and improve his own. Let us, similarly, in surveying the field of strife for supremacy in the dairy trade, observe:—

I. What marked advantages over the east are possessed by the west?

II. Wherein has New England advantage over western rivalry?

III. How may New England dairying more successfully meet the competition of the great west?

I. WESTERN ADVANTAGES.

Several circumstances conspire to favor western success in dairying, among which may be mentioned:—

1. Cheap feed.
2. Large territory and large numbers.

3. Longer pasture season.
4. Ready use of new methods.
5. Educative agencies.

1. *Cheap Feed.* — This advantage is of stupendous importance. The low cost for food used in making western butter more than any other one factor makes eastern competition increasingly difficult. The western farmer can usually raise a ton of dry matter in silage at less cost than can his eastern brother; his hay is grown cheaper; and, as for grain feeds, the comparison is most disheartening. Mill stuffs average throughout the west two-thirds of eastern prices; corn is so plentiful that it is sometimes cheaper to use as fuel than is coal. Professor Haecker reports the manufacture of butter from a large herd at less than 10 cents a pound for food the year round, buying, as he told the writer last month, bran at \$4 to \$4.50 per ton *f. o. b.* Minneapolis in car-load lots. The difference in freight rates on a ton of bran and on the butter which a ton of bran will make is large. Such a handicap as this is indeed difficult to overcome.

2. *Larger Territory and Numbers.* — I think that I have said enough under this head, when considering the statistics given a few minutes ago, to suffice, except perhaps to call attention to the surplus of production over consumption in the west, and the reverse of this condition in New England, and to refer to the fact that the volume of the west's production gives it a standing in the commercial world not accorded to smaller outputs.

3. *Longer Pasture Season.* — This advantage pertains more particularly to Missouri and Kansas. Two southern central States, Kentucky and Tennessee, are likewise rapidly becoming dairy States in the true sense of the word. The milder climates and the prolongation of outdoor bovine life in their States tends to lower the cost of butter production.

4. *Ready Use of New Methods.* — Under this heading and again further along in this paper I shall take occasion to refer to the ultra-conservatism of the New England farmer. The western creamery and factory proprietors or managers, as a class, are far and away ahead of easterners in similar positions, in their study of newer methods and appliances and in adopting the same wherever feasible. For example, the fol-

lowing statement was made at the last meeting of the Vermont State Dairymen's Association by a prominent commission merchant of Boston, one who has large acquaintance with Vermont creamery goods: "I have been told by good authority that last year about 90 per cent of all the butter from the west shipped into New York was shipped in parchment-lined tubs. I do not know of a single creamery in Vermont that is lining its tubs with parchment paper." The statement was not denied. The first skim-milk weigher in Vermont was put in last winter; they have been used in the west for lo! these many years. I cite Vermont since I know its conditions better than those of the other New England States, because it is the typical eastern dairy State. It is common remark among commission men and the dairy supply trade that the west promptly meets new demands,—anticipates them, perhaps; that, while sometimes investing in new apparatus of doubtful utility, or adopting methods of questionable wisdom, it leads in new ideas. It seems to me that the east may well copy from the west in this matter, and that we should remember the adage that he who makes no mistakes generally makes nothing.

5. *Educative Agencies.*—With all due respect to the good work being done along agricultural lines by this Board, by the Massachusetts Agricultural College and Experiment Station, by the agricultural press and by the various colleges, stations and the press of other New England States, I submit that the agricultural educative agencies in the west average higher in efficiency, in getting home dairy knowledge to the people, than do those of the New England States. And, more important yet, as has been already indicated, the eyes and ears of their constituencies seem to be more open, their hearts and minds more receptive and their hands and energies more active to apply the dairy gospel than is the case in the east. They are "built that way;" they hustle more; they have earned their success, and they deserve it. Let us emulate them.

II. EASTERN ADVANTAGES.

There is, however, a reverse side to this picture. New England dairying possesses certain advantages which have been helpful in the past, and which may be useful in the future. They may be enumerated as follows:—

1. Better cows.
2. Former reputation.
3. Proximity to market.
4. Special goods.

1. *Better Cows.*—It is quite safe to say that New England cows will average better than those of other sections of the country, and that the production per cow is larger than elsewhere. The cow is the foundation of all branches of dairying, hence this is an important advantage, one not to be underestimated, one which should in every possible way be increased. Of this more anon.

2. *Former Reputation.*—Time was when Vermont butter, like Vermont maple sugar, was the standard of excellence throughout the east. “Northern creamery,” that is to say, New Hampshire and Vermont creamery butter has heretofore sold and often sells to-day on Boston market at a higher figure than western brands of the same grade, because of a reputation, founded, it must be acknowledged, more upon tradition than by actual superiority. This old-time reputation has been a marked advantage; but tradition cannot much longer sustain this distinction, in view of the lessening proportion of New England’s total output that is sold in the large markets.

3. *Proximity to Markets.*—“Once upon a time,” as they say in fairy tales, the nearness to market was an important factor in the trade; but refrigerator cars, cold storage, frozen butter, low freight rates and the like have made this advantage a broken reed, upon which none can lean with safety.

4. *Special Goods.*—Thus far the west has not been able to compete with the east in the New England markets in the milk or cream trade. This trade, as the audience well knows, forms a large and growing outlet for New England dairy products. When, however, we consider what pasteur-

ization and freezing do, when we think of what liquid air has done and may yet do in economic fields, surely it is far from safe for us to assume that the great west will not before long be placing frozen bricks of milk and cream, pasteurized cream, sterilized condensed milk and the like in New England markets, on an equal footing with home-made products.

Let us now balance accounts. Against the cheaper food, larger area and numbers, and modern methods of the bustling west may be placed a somewhat better grade of eastern cattle and a milk and cream trade thus far not threatened by competition. The candid observer must confess that the west has the best of it. The difficulty of competing with the cheaply made butter of the west is yearly increasing. No protective tariff can avail; legislation is to be invoked to no purpose. The business conditions of the present day are very different from those of our forefathers, and will so remain. It is folly to bemoan the high prices of former days, useless to combat modern business conditions with out-of-date methods or ancient prejudices. I know of no easy way to success, no royal road to competency, no sure cure for the ills of this dangerous competition. The sole resource of eastern dairymen lies in the awakening of their own energies. They may most surely stem the tide of western rivalry by a thorough study of the dairy business, by the application of business methods to their vocation, by the adoption of such western ideas as seem applicable to eastern conditions.

The dairyman of to-day, to be successful, must work with his head quite as much as with his hands. He must call upon his brain as well as upon his muscle. He may well recollect the remark of one of the famous painters of the last generation, whose coloring was the despair of his fellow artists, who, when asked with what he mixed his paints to produce such wonderful effects, replied, "With brains."

III. HOW TO MEET WESTERN COMPETITION.

In my judgment, those engaged in dairy husbandry in New England, in order to hold their local markets against the rapid inroads of western competition, need to consider

three fundamentals, to study, if you will, three courses in the school of dairy experience : —

1. Economy of manufacture.
2. Markets.
3. The dairy business as a whole.

I freely grant that this triad is not stated in a logical order; that, in putting the dairy business last, I seem to have placed the horse after the cart. Yet I wished to make this distinction between headings 1 and 3, for reasons which will be apparent as the discussion develops.

1. *Economy of Manufacture.* — Under this heading one needs to consider means of economizing, either by lessening cost or improving plant. I have divided the matter, for convenience and clearness of discussion, under five sub-heads : —

- (a) Machines.
- (b) Crude stock.
- (c) Methods.
- (d) Nature of products.
- (e) Character of products.

(a) *Economy in Machines* (*i. e.*, cows, dairy apparatus, etc.). — Some dairy authorities have been prone to look upon the cow as a machine, to speak of the food as fuel to run the engine and of the milk as the product of machine work. This view is one-sided, and in many ways ill-conceived. Yet, for the purposes of the present argument and classification, the cow may well be considered as a part of the dairyman's plant or machinery for manufacturing finished products. I have already said that New England dairy cows average better, that is to say, produce more, than do western cows. So far, so good; but better is not best. When the odds are so heavily against us, every effort needs be made; and here endeavor is readily directed. Let us turn for a moment to Vermont statistics. Some years ago Hon. Victor I. Spear, then statistical secretary of the State Board of Agriculture, gathered data in the course of his official work showing the average butter production per cow in that dairy State. The result showed the average annual yield to be 156 pounds per cow, several entire townships being over the 200-pound mark and some below the 100-pound limit. The range of production was from 92 to 259 pounds for entire

townships. Now, 156 pounds is, I believe, a larger average production than that of any other State in the Union; yet it is far from what it might be, — far from what it ought to be. It is not a yield which, at present prices for butter, for grain feed and for hired labor, will add largely to our wealth. The margin of profit is dragged down by the keeping of unprofitable animals, — cow boarders.

Before the Babcock test was devised, when ready, cheap and accurate methods of estimating the dairy worth of individual animals were lacking, there was valid excuse for keeping bovine dead-beats; but no man of even ordinary intelligence can plead inability to-day. A simple test is at hand, one that requires but a minimum outlay of time, money, knowledge and brains. Many a man who has used the Babcock test in a proper manner to determine the merits of his various animals has made more money with half his herd than formerly when the barn was full. Some years ago the dairyman of the Vermont Experiment Station left us to become dairyman on the Long Island estate of Mr. W. K. Vanderbilt. Soon after entering upon his new employ he wrote me as follows: "The Babcock test has killed a dozen of our cows. Mr. Vanderbilt says he cannot afford to keep cows which do not pay their way." If we may judge by the actions of many of our dairymen not only in New England but the world over (and we must remember that actions speak louder than words), — if, I say, we may judge by their actions, there are thousands of dairymen who can afford to keep cows which Mr. Vanderbilt is unable to keep. The very first step which should be taken by every dairyman whose average production per cow is under 200 pounds, is to grade up his herd by purchase or by breeding, or both, as seems most expedient. The purchase of a good bull is usually the first move, followed by good care and judicious feeding of such cows as are worthy of it. May I not suggest here, moreover, that the raising of a larger proportion of the calves now slaughtered would be in the direction of wisdom? Recent statistics taken by the State Board of Agriculture of Vermont show a marked decrease in the number of dairy cows in that State. This decrease is brought about more particularly because of large sales to

Massachusetts, and the failure of farmers to raise their own stock. If more of our dairymen would make use of the Babcock test, determine the dairy abilities of their individual animals, and raise calves from such cows as prove to be most successful milkers, it would go far towards elevating the standard of excellence in the herd. The class of cows and their adaptation to the particular kind of dairying in view is of importance. I have no desire, however, to enter into the quarrel of the breeds, but am simply suggesting the wisdom of looking into this matter, and the folly, as Governor Hoard aptly puts it, of hunting for birds with a fox hound, or for butter with a beef animal.

The matter of dairy apparatus and appliances merits careful study. The market for all classes of dairy goods becomes yearly more critical, and margins of profit grow continually more narrow, particularly if modern apparatus and methods are not used to meet these demands. Mill owners throw aside machinery which cost tens of thousands of dollars, machinery but little worn, and replace it with other apparatus perhaps more costly, which in its turn, in a few years, with its value hardly impaired by use, is cast aside for yet another lot of machines. Why? To save a fraction of a cent in the cost of making a yard of cloth, to lessen the expense of labor, to reduce power bills,—in short, to economize in manufacture. Similarly the wasteful shallow-pan or deep-setting creamer of earlier days must for greatest profit be superseded by the centrifugal separator,—the eight-quart can by the sealed glass bottle. Whatever class of dairying New England is engaged in, it is the part of wisdom to adopt such apparatus as will lessen waste and improve quality. It is not my desire to recommend this or that piece of apparatus, but in general to urge the wider use of modern machines for dairy purposes.

(b) *Economy in Crude Stock* (i. e., home-grown and purchased feeds).—This, as Rudyard Kipling says, is another story. The discussion of economical dairy feeding in all its phases would take far more time than can be given to it here. Indeed, the importance of wise choice in this matter can hardly be overestimated. For full two and one-half hours yesterday afternoon the dairymen of the State

of Maine and myself wrestled with this problem at Portland. The charts which I have hung on my right were the banners under which I fought. In the brief time which can be allotted to this section of the general subject, I can hardly do more than allude to the salient points. Without any attempt to go into the matter of the science of stock feeding, let me call attention to what appear to me to be the more economical roughages and concentrates, and what are probably uneconomical at ruling prices.

I want you to remember, as I have done, a remark of Director Jordan of the New York station, made in an address to the Vermont Dairymen's Association last year. His epigrammatical statement struck me as very apt, and seems worthy of emphasis and reiteration. I believe that it strikes the key-note of the successful dairy practice of to-day, in so far as it pertains to feeding. He said that the "proper function of the farm in dairy feeding is that of a carbohydrate factory, and the proper function of the market is that of a protein supply." What did he mean by this statement? He meant three things: (*a*) that carbohydrates were grown upon the farm with relative ease, but that it was difficult and usually impossible to grow enough protein upon the farm to provide a large number of dairy cows with a balanced ration; (*b*) that, since the by-products of several industries are notably rich in protein and are sold at fairly reasonable prices, it was sometimes cheaper to buy this material than to raise it; (*c*) that, while the farm growing of protein was to be encouraged, yet it was usually in the line of economy to grow carbohydrates in as large amounts as possible, and to buy protein in order to supplement this growth, thus properly balancing the ration, provided the class of cows to which the ration was fed was of the proper grade.

In my judgment, the more common roughages and concentrates may be classified as economical and uneconomical for feeding dairy cows, as follows:—

Economical roughages: (1) early-cut hay; (2) silage from mature corn; (3) oats and peas; (4) clover.

Uneconomical roughages: (1) late-cut hay; (2) silage from immature corn; (3) roots; (4) new and untried crops.

Economical concentrates : (1) cotton-seed meal ; (2) linseed meals ; (3) certain gluten meals and feeds ; (4) dried brewer's grains, malt sprouts, etc. ; (5) bran, middlings, etc. ; (6) corn meal (sometimes).

Uneconomical concentrates (for purchase) : (1) corn meal (usually) ; (2) oats ; (3) oat feeds ; (4) mixed feeds or provenders ; (5) condimental foods, etc.

In the amount of time which we have at our command, it will hardly pay me to indicate why I have listed some of these materials as economical. It may not be amiss, however, for me to spend a brief moment in giving the reasons why I have classified some of these as uneconomical. Late-cut hay is relatively indigestible, its quality notably inferior. Silage from immature corn contains but a small proportion of the feeding value that may be obtained if the kernels are allowed to reach the glazing period. Roots, while valuable for dairy feeding, are relatively expensive sources of digestible carbohydrates, as compared with the corn crop. New and untried crops were better experimented with at the stations than by farmers. Of the purchased concentrates, corn meal is usually uneconomical, because it is rich in carbohydrates, and it is protein rather than carbohydrates which we should buy. Oats are usually uneconomical at the prices asked. Oat feeds are generally made up of oat hulls, refuse oats and the like, fortified sometimes with other materials, and at the prices asked are relatively expensive. Much the same may be said of many of the mixed feeds and provenders. Touching condimental foods, it may be said that they seldom if ever increase the production of or materially better the condition of healthy animals. Of course, in selecting foddors and feeds and in making up the ration, one needs to consider not only the digestible dry matter and digestible nutrients, but likewise the effect which the various materials may have upon the health of the animal, upon the quality of product, upon the quality of manure, the relation of cost to value and the dairy character of the herd. This latter point in particular is worth considering. It is folly to feed high-grade feed to low-grade cows.

(c) *Economy in Methods.*— Shall New England dairying be private, or associate? Is the old-time idea of a

farmer's independence to be emphasized, or minimized? Rightfully or wrongfully, wisely or unwisely, the tendency of all modern business operations is in the direction of aggregation. The department stores, the trusts, combines and the like are familiar instances. The same trend is evident in dairy operations. Co-operative or proprietary creameries and cheese factories and the like are thickly dotted all over the map of New England, outside of the section devoted to supplying home milk to the metropolitan district. Dairy butter, as such, even though of first quality, ranks below creamery butter of even grade. The question answers itself. New England dairying, outside of isolated cases, must of necessity become more and more associate in its methods, in order to compete successfully with the products of similar methods made elsewhere.

(d) *Nature of Products* (i. e., milk, butter, cheese, cream, by-products, etc.). — Thus far western competition has been felt in butter and in cheese. New England dairymen have only had to compete with each other and to wrestle with the contractors in the matter of milk supply; while the cream business is still profitable. The consumer now takes dairy products in several different forms, — milk, butter, cheese of a dozen kinds, cream, condensed milk, by-products, certified milk, modified milk, ice cream and the like; while the by-products, skim-milk, buttermilk, and cheese, are made into a considerable number of materials of dietetic or industrial use. Did time permit, I would like to go into the consideration of the considerable income which New England dairymen may yet obtain through a more reasonable and economical use of by-products. This, however, is of the future rather than of the present. Milk, butter and cheese must always be made the main dairy products. Many individuals may solve for themselves the problem of competition, both western and of home origin, by entering into, alone or in combination with neighbors, the manufacture of certain dairy specialties, such as certain brands of cheese, of certified milk, or things of like character. I doubt whether, for instance, the certified milk business is likely to be overdone in the vicinity of Boston for many years. Many of the foreign cheeses, for which fancy

prices are paid, may be closely imitated on this side of the water. Indeed, a few New York and Wisconsin factories are to-day making several cheeses practically identical with the imported article.

(e) *Character of Products (i. e., quality).* — The best of cows, be they fed ever so well, their milk sold as such or made into butter, cheese or what not, avail not in the struggle to meet western competition if the quality of the final product be inferior. Our western cousins have made rapid strides in this respect in recent years. The advantages already enumerated, particularly the educational ones, have been important factors in this advancement. The superiority of New England dairy products no longer stands unquestioned. It remains, therefore, for us to put forth every effort to improve what is already good. We must gild refined gold, — the lily shall be painted. How is this to be brought about? I know of no one thing more potent for ill in this matter than the bacterial content of the milk furnished by the different patrons of a creamery, cheese factory or milk car. Other considerations, such as character of feed, stage of lactation, method of handling, etc., enter in to affect the quality of the product, — factors which would be well worth our attention, did time and space permit. I should distinctly fail in my duty, however, if I neglected to refer to the vital relation of the germ content of milk to its usefulness in dairy operations.

I need not tell this audience the now trite story of the bacterium, how its growth and multiplication in milk causes the familiar souring, how sometimes desirable aromas, sometimes disagreeable flavors, are developed by its growth, or how certain diseases may be at times communicated through its presence in the milk. It is proved beyond doubt that the control of the bacterial content of milk is the great desideratum of modern dairy management. Exclusion, destruction and retardation should be the watch-words. Keep them out, kill them out, check their growth. How may this be most certainly yet simply accomplished? Cleanliness and sanitation tend to keep them out; live steam, sunlight, sterilization, pasteurization, disinfection, kill them out; and refrigeration serves best to check their growth.

In proportion as New England dairymen, working privately or associated with others, keep their stock, barns and feeds clean and healthy; in proportion to their free use of live steam on dairy apparatus and utensils, the sunniness of their cow barns and milk rooms, and their free use of ice; in proportion, in short, to their study of economic dairy bacteriology,—there will follow the enhancement of the character of their dairy products. Such procedure will tend to make their products more uniform, more attractive to buyers, and lead to larger consumption.

Some time ago a series of questions touching dairy operations were sent out by the dairy division of the United States Department of Agriculture to several heads of creameries the country over. One of the questions was essentially as follows: What one thing, if it could be brought about, would, more than any other, help the dairy industry and dairy products in this country? The overwhelming majority of the replies,—not a plurality, mind you, but a majority,—stated that more care in the handling of the milk after it was drawn from the cow and before it reached the factory was the one thing needful. The dairyman himself is mainly at fault in the matter,—a fault which may be remedied by a not unreasonable amount of care. The discouraging feature of the matter, however, so far as it pertains to associate dairying, is that one bad mess of milk drags down the entire lot to its low level,—it leaveneth the lump. And not unnaturally the dairyman says, “What avails it for me to use care, to steam my pans, to ice my milk, to dip it, to aerate it, to jacket my cans, to groom my cows, to feed my dry fodder after milking, to ventilate my barn, only to have my milk mixed at the creamery with John Doe’s, who never washes his cans, whose cows lie in filth and darkness, and whose milk must be well-nigh sour when taken into the factory?” John Doe’s milk ought to be turned back from the weigh can. The creamery taking John Doe’s milk and making on that account a poorer grade of butter ought not to get a good price for it. Unfortunately, in many localities, notably in my own State, creameries are so thickly located and competition is so keen that generally John Doe can sell milk of pretty tough quality to some one. And,

moreover, rivalry between commission men is sometimes sharp enough in certain markets to cause the payment of over-high prices for goods not strictly of a grade meriting them.

There are ways, however, in which any creamery which is in earnest in this matter can grade up the quality of its milk so far as it relates to bacterial content : —

1. It can start a campaign of education among its patrons. The dairy papers preach the gospel of cleanliness ; the bulletins of the various stations and in particular those of the dairy division of the Department of Agriculture explain the matter from A to Z in such a way that he who runs may read ; the very unoriginal remarks I have been making from this platform to-day are reiterated at institutes, dairy schools and farmers' clubs the dairy world over. Hold patrons' meetings, discuss these things among yourselves, show that care of milk pays indirectly if not directly.

2. Use the alkaline tablet, the rennet and the nose tests on the milks delivered by the various patrons. Use these before the patrons ; let them see the differences ; let them note the effects thereon of care and of lack of care of the milk ; let them see how increasing nearness to sourness calls for more alkaline solution ; how milks with incipient taints are detected by the curd test and by the nose test ; how unerringly the batch of milk that caused that bitter taste, that off flavor, is ferreted out by these secondary tests. Use the alkaline tablet solution from time to time at the weigh can as a warning, as an optical illustration to John Doe that his milk is not being properly cared for. It has worked elsewhere, as has the Babcock test in years past, to force the indifferent and the careless to better ways. The test may be made by the man at the weigh can as rapidly as he can weigh the milk. Add to this test a little moral suasion and a good backbone, and the character of the milk used and the products made can be graded upwards to quite an extent.

I cannot refrain from referring at this point to the dairy history of a typical Vermont hill town in the northern part of our State. It has so much of suggestiveness in this connection, and is so good an illustration of the best of New

England butter dairying, that a few moments can well be spent here considering the results of the application to actual business conditions of the general propositions that I have been laying down, in showing how the dairymen of the town of Ryegate meet western competition in dairying.

In the first place, they have the men, of sturdy Scotch descent, shrewd, cautious, with natural business instincts. It's a Scotch town throughout. Then they have cows worthy of the name, averaging yearly over 250 pounds of butter per animal, — all included, good, bad and indifferent. Their pastures were naturally good, and they have tried to keep them good. They have put thought and care into the study of breeding and feeding.

It is a God-fearing community, of truly Christian spirit, yet it has taken a leaf from the Mohammedan gospel, and placed cleanliness — dairy cleanliness, dairy sanitation — next to godliness. They have a live farmers' club, several creameries: pay creamery butter-makers and managers high wages, and hence get the best of men; put business methods into the whole process of milk making, butter making and the marketing of the products. What is the result? As prosperous and contented a farming town as you may find in the length and breadth of New England, with the foundation of its success laid in butter making.

I have spent full long a time upon the considerations of manufacture, and must now turn to those of sale. It matters not how much or how good one's products, if they are not sold to advantage. Hence markets become very properly the next division of our subject.

2. *Markets.* — It will be recollected that I stated at the outset of this discussion that what I did not know about marketing dairy products would fill a book. It is a phase of the general subject with which I have no practical acquaintance. The propositions I have advanced under this heading are entirely of a second-hand nature, and any lack of proper stress laid upon this important matter should be attributed to my unfamiliarity with the subject.

It seems right to consider the matter of markets under four sub-headings: —

(a) The general domestic market.

- (b) The private domestic market.
- (c) Foreign markets.
- (d) Is not dairying in danger of being overdone?

(a) *General Domestic Market.* — The bulk of New England butter and cheese is sold on the general market, and competes here with western-made goods. While this is true, each year a larger proportion of the total New England make is sold in the smaller markets and direct to private customers. There is much to say in favor of this trend of trade, yet there is another side to the question, one which appeals particularly to the dealer. I doubt if I can make this point more clear than by quoting directly and at some length from a letter received by me some time ago from a prominent Boston commission merchant: —

Quotations and prices are established by large markets. The markets are controlled or affected only by the merchandise that constitute important factors in the daily transactions. Our local creameries each year send a larger proportion of their product to the small markets and what are called private customers. The result is that New England made butter is becoming each year a less important factor in the Boston and other large New England markets. The time is not far distant when Boston will, like New York, quote prices and establish values in reference to western goods only, and the premiums heretofore paid for Vermont butter will be a thing of the past.

Another way of looking at this phase of the subject is this. More and more each year regular wholesale dealers find that their shippers send only such butter as the creameries cannot sell directly. This causes the supply to be very variable and uncertain. For instance, last week we received about 1,200 pounds from one Vermont creamery that for several weeks had sent nothing. We do not know whether this week we shall receive more, less or nothing; consequently we cannot plan in advance where to dispose of the goods, and all our other shippers will have an advantage over this one. Then, again, we cannot advocate the merits of a creamery when we do not know whether or not we will be able to supply our customer with that particular brand the next time he has occasion to make a purchase. We can always secure from the great west all that is needed, and of such quality as is desired. This we cannot do with butter of local manufacture to any such extent. Thus it is for the advantage of the

dealer to advocate only such goods as he can feel reasonably certain he can furnish to his customers in such amounts and at such times as they desire. For that reason I would suggest the policy of sending to large markets and large dealers, in order that New England produced butter may be the controlling factor in our own markets, and in order that those whose transactions establish market values may not be driven to the west for their only reliable source of supply.

I have quoted thus at length because this statement expresses the case fully yet clearly, and deserves weight as a view of the seller. Whether the maintenance of the position of New England butter as a controlling factor in New England markets is a sufficient offset to the immediate financial advantage often gained by direct sales to "private customers" and to small markets, is a question I am not able to decide. I am inclined to think, however, that the latter consideration will usually rule.

(b) *Private Domestic Market.* — This market does not cut much of a figure in the public eye; it makes but little if any show in the general returns; yet, as has been already stated, it is yearly becoming a more and more important factor in New England dairying. The arguments in favor of this market are obvious, and need not be enlarged upon. A good private trade is par excellence the best way in which to dispose of dairy products. I should not myself feel inclined to worry about western competition if I had a good private outlet for my products. The average dairyman and the average creamery, however, are not as a rule in a position to avail themselves of the chance, — a fact which ought to act as a spur to their energies.

(c) *Foreign Markets.* — American cheese was formerly sold in large quantities in British markets, but the trade has for some time dwindled to relatively small proportions for two reasons: First, the manufacture and sale of filled cheese, a fraud which fattened a few dishonest pocket-books, and well-nigh ruined a nation's dairy trade; second, the rapid increase in the volume and in the quality of Canadian cheese. The national law controlling the manufacture of filled cheese, as well as State enactments, will probably aid in the partial recovery of the lost ground, yet our former trade can never

be regained. More than this, the fraud we perpetrated has reacted upon us to raise a presumption of suspicion in British minds against all our dairy products,—a feeling which it is difficult to allay. American butter has been offered in the English market to but a slight extent until recently. That great consuming nation has relied largely on Denmark, Holland and on distant Australia for its supplies. One of the first acts of the present Secretary of Agriculture was to study English market demands by the shipments of considerable amounts of American butter from many sources, thus working up somewhat of a trade. This action has not only acquainted English consumers with the merits of American goods, but has served to teach our butter makers the needs of English markets. Great Britain is naturally prepossessed in favor of her own colonies, while the Danish and Dutch butters grade higher on the average than those of any other country (and it may be stated parenthetically that this is due to the general adoption in these countries of modern methods, cleanliness, and particularly of the teachings of dairy bacteriology). This combination is difficult to meet in competition, yet good goods will sell well there. Certain Vermont creameries have already established London trade, which promises to prove remunerative. In 1893 the United States exported to England 2,293,000 pounds of butter; in 1897, 15,419,600 pounds, —an increase of nearly 700 per cent. The increase in the exportation of Canadian butter has been even greater.

(d) *Is there not Danger of Over-production?*— This is a very pertinent question. The old yet ever true answer may be made, that, while there are always too many inferior goods made, there has not yet been a surplus of the best grade. There is always room at the top. I do not believe there is any immediate danger of over-production. Increase of population more than keeps pace with the increase in the number of cows, because of the slaughter of poor animals and calves. The consumption per capita in this country and in Europe of the various dairy products, milk, butter, cheese, cream, milk foods, condensed milk, etc., has greatly increased within the last generation, and particularly within the last fifteen years. These two factors, larger number of con-

sumers and larger per capita consumption are, in my judgment, sufficient to take care of the increase in production for many years to come. The increase in the number of consumers has come as a matter of course. The increased consumption per capita, however, has been the direct result of the marked improvement in the quality of the various dairy products, — a betterment which has been brought about by the educating effect of constant agitation upon the minds of dairymen (the makers of raw material, milk) and of creamery men (the manufacturers of finished products, butter, cheese, etc.). This education from the press and the platform, from the laboratory and the class room is resulting in the making of better milk, from which better butter and cheese can be made. It has taught the food producer the money value of palatability and attractiveness.

Let creameries multiply, cheese factories dot the landscape, the milk trains penetrate yet further from the metropolis, the cattle on a thousand hills cover ten times a thousand, and farmers the country over turn to that most rational system of husbandry, whose foundation lies in dairying, — let all this happen, yet I fear not over-production, the bugaboo of timid souls for generations past; I fear it not, so long as a high grade of dairy products is made to tempt the appetite to their larger use.

3. *The Dairy Business.* — At the outset I admitted that, in formulating my scheme of division, I seemed to have interchanged the locations of cart and horse; also that much which might be said under the head of “economies of manufacture” could very properly be considered under the present heading; that, in short, the two were closely alike, and not capable of clear differentiation. I made the distinction, however, deliberately, as I wanted under the one heading to lay stress upon the economic side of the problem, and in the other, that now under consideration, to place the emphasis upon the educational side. The remainder of my appeal will not be addressed directly to the pocket-book, but to the brain. Under this heading I want to consider: —

(a) Dairy education.

(b) The use of the Babcock test at the factory and on the farm.

(c) Dairy sanitation.

(a) *Dairy Education*.—With dairy papers, dairy institutes, dairymen's associations, dairy schools, dairy bulletins, State and national, with dairy information and education on tap for the asking, and all free and most of it reliable and worth having,—it does seem as if there was little need for ignorance touching the better methods of dairy husbandry. Yet, if one may judge by conditions as found, there is still lamentable lack of information on every hand regarding the essentials of modern dairy practice. Many dairymen have made great advance along this line, but hosts still stand aloof, and, by their actions, proclaim that “ignorance is bliss.” There is still need of missionary work. The great difficulty, however, is how to get at those who will not help themselves, who refuse to read, who will not grade up herd or product, who decline to inquire, who are wedded to their idols, whose sluggishness and indifference affect primarily their own welfare and secondarily injure that of their neighbors and associates in business. Narrow-minded, prejudiced, carping, dissatisfied, suspicious, behind the times, they will not see the light, even though it be flashed in their very faces. It is this class of men who growl at the tariff; who complain that dairying doesn't pay; who think the creamery proprietor a thief, the Babcock test a fraud; to whom it never occurs that the fault lies in their own inability or unwillingness to study their calling, to apply business principles in their work. No sense of their personal responsibility for their ill success appears to oppress them. Instead of seeking to imitate their prosperous neighbor, successful because of the application of modern ideas in dairying, they too often are angry with and jealous of him. They will not see that, just as success in other lines of business demands study and application of new economic ideas, dairying, to be profitable, must be studied.

I was amused at the correspondence published some months ago in a prominent dairy paper. The writer urged the editor to “let up on those shiftless farmers, who haven't intelligence enough to read such a paper, nor energy enough to profit by it if they did read it. Publish a paper for intelligent men, and let the stupids go.” In response to the

editor's query whether he ought to stop trying to reach those farmers who refuse to make of themselves intelligent dairymen, he replied that the paper's course was "not wrong, but blamed foolish." I fear that I have been blamed foolish for spending so much time and rhetoric upon this phase of the subject; but this dead load of inertia is to me the most discouraging feature of all, — the more so because I see no way of remedying the evil. "Keeping everlastingly at it" will diminish their numbers, but can never do away with the tribe as a whole.

I think I need not remark that I do not fail to appreciate the high intelligence, the business ability of thousands of our New England dairymen. My strictures do not apply to them. Yet I plead even to these to make the widest possible use of dairy literature and dairy education, both for their own benefit and that by their study and their practice they may be "a light to lighten the Gentiles." Many will believe a neighbor's say-so who would laugh at the idea if found in a book. Many scorers of experiment station and farm institute work are unconsciously practising the precepts they deride, getting them at second-hand from some townsman. In proportion as we apprehend dairy knowledge, we better our own chances of success and indirectly aid our section to cope with competition more successfully.

(b) *The Use of the Babcock Test at Factory and Farm.* — I have already spoken of the usefulness of the Babcock test as a means of detecting unprofitable cows. Perhaps further reference is uncalled for, yet its potentiality for good is so great that too much emphasis cannot be laid upon its use. Would that more dairymen would try its effects upon their herd and pocket-book. But here, as elsewhere with other things, those most needing its services value them the least. It's the old problem, the one with which we were wrestling a moment ago in a slightly different form, — how to help those who will not help themselves. I believe that a more open and enlightened policy on the part of factory managements would be of marked advantage, — that they could well afford to test patrons' cows individually for them at nominal rates. I think a young

man or woman with a Babcock tester travelling from farm to farm might pick up quite a few pennies and do much good by making farmers' tests for them.

(c) *Dairy Sanitation.* — I fear that I may be treading upon dangerous ground if I touch upon the relation of bovine tuberculosis to the dairy industry and to western competition; yet it seems to me that a word is necessary. I will not attempt to say what is the part of wisdom for you in Massachusetts in this matter. The situation is in some important respects different from that in Vermont. I have no hesitation in saying, however, that eradication is proving the wisest policy in that State. Over a fifth of its entire bovine population has been subjected to the tuberculin test. It has cost but 24 cents per head to test them, and only a small percentage of disease has been found. Whole townships, almost, I may say, entire counties, have only tested cows therein. A constantly increasing number of creameries receive milk from tested cows only, and advertise the fact in the sale of their goods. It helps in competition; it raises the price in certain markets. Similarly, the knowledge that the animals are kept under sanitary conditions and in cleanliness aids in the sale of the product, especially if it be milk, and if these facts be called to the attention of a discriminating constituency of consumers.

My hearers will recollect that I told them at the outset that I had no startling news to declare, no certain remedy to propose for the ills of western competition. The truth of my statement is now realized. I am not sure that I feel sorry that there is no easy way to meet this rivalry. Were there such, incentives to earnest work would be lacking. There is now every reason to study, to strive, to progress. I have simply emphasized and reiterated those things which I doubt not were known to you before. It may be, however, that in this far too imperfect survey of the dairy situation I have dropped hints which may be of service to some in bettering their practice and enlarging their experience. In some direction, perhaps, your outlook may have been made more clear by words of mine. I

surely hope so, for what are reading, study, practice and experience worth, except as guides to future and to better endeavor?

Coleridge, — whose works we of the University of Vermont in particular value, since the foremost American student of that author was in years past our president, — Coleridge says, “To most men experience is like the stern lights of a ship, which illumine only the track it has passed.” Let us remove our light of experience from the stern to the prow; let us rather liken it to the headlight of an electric car, illumining the path before; let us as dairymen walk in the light of past experience — our own and that of others, if it be trustworthy and applicable to our circumstances — to higher planes of achievement in the varied phases of our calling.

The CHAIRMAN. The time which we now have to use in the discussion of this address is limited. Have you any questions?

GEO. P. SMITH (of Sunderland). I want to emphasize one point the gentleman spoke of, and that is, getting good cows. I have practised raising all my heifers, testing them, getting rid of the poor ones and keeping nothing but the best, until I have made a pretty fair success of the business. Good cows are the foundation of the whole thing. People think five or ten dollars more for a cow that will give a larger quantity of butter or milk is too much to pay. They have never figured it out, to see. Lots of cows will bring in five or ten or fifteen dollars more in a year than others, and such cows are worth more. Another thing, a good cow is improving your stock as long as she lives.

Mr. MAGILL (of Amherst). One other point: there is an indifference on the part of dairymen in regard to progress. I believe there are ten directors of creameries in this town and vicinity. In looking about the audience I have seen only two directors of creameries. I would like to ask the directors of creameries in Amherst and vicinity to raise their hands. [The request was complied with.] There are three directors here, one from one

creamery and two from another. I think the ultra conservatism mentioned by the speaker is demonstrated.

Secretary SESSIONS. I want to say that anybody can lead a horse to water, but it is not everybody who can make him drink.

Prof. F. S. COOLEY (of Amherst). I believe that I have a peculiar right to say a word on this occasion, from the fact that I also am connected with dairy education. I am connected with the Agricultural College dairy school and the department of animal husbandry and dairying. I am connected with the dairy business as a farmer and a producer of milk and cream. I am interested in the sale of these products in the retail market, and what I want to say is in hearty support of all that has been said and by way of special emphasis on a couple of points that have been brought out. I believe the last speaker had one of these points in mind when he called for better cows. I have had my classes figure out in a business way the difference between a good cow and a poor one. The average cow for Massachusetts — which, by the way, is the same as the average cow for Vermont — costs about \$40 a year for her keeping, at the present market price of feeds, and her return is not far from \$37.50. She is therefore kept at a loss of \$2.50, plus the interest on the output. There is a greater difference between good and poor cows than the farmers realize. A cow must pay an income of 6 per cent, taxes at 2 per cent, shrinkage at 25 per cent on the difference in the value of the animal; and we find that a cow that will make 8,000 pounds of milk on that basis is worth \$190 as quickly as the average cow is worth \$25; a cow that will make 7,000 pounds of milk is worth \$145; and a cow that will make 5,000 pounds of milk is worth almost \$100. She will pay the interest, taxes and shrinkage quicker than the 150 pound butter cow will on \$25. That is one thing.

I do not advocate pure-bred cows for the general farmer, — grade cows are just as good; but I do advocate the use of a pure-bred bull in all cases. The saying is that “the bull is half the herd.” That is not so, — at least, it should not be so. If you have cows of mixed breeds or native or

grade cows, and mate them with a sire of the same kind, then the male is half the herd; he is equal to the cows. The male should be nine-tenths of the herd, and farmers should be paying for a first-class male, instead of for grades and "scrubs."

Adjourned at 12 M.

AFTERNOON SESSION.

Secretary SESSIONS at 1.30 P.M. called the meeting to order and said: The vice-presidents and the executive committee have directed me to ask Mr. D. A. HORTON of Northampton to preside this afternoon.

Mr. HORTON. In introducing the speaker, I will say, for the information of those who do not know, that he is a Hampshire County boy, a graduate of your Agricultural College, and at the present time professor of agriculture in the Storrs Agricultural College, and also vice-director of the experiment station at Storrs, Conn. Prof. CHARLES S. PHELPS will now address you on "Grasses and other forage crops."

GRASSES AND OTHER FORAGE CROPS.

BY C. S. PHELPS, STORRS (CONN.) AGRICULTURAL EXPERIMENT STATION.

The growth of the dairy industry throughout the central west, and the consequent competition which the east must encounter, make it essential that the greatest economy be used by our dairy farmers if any profits are to accrue from the business. Our hope of success in dairying lies along the lines of better stock, a better system of feeding and superior products. It is important that we should grow as much of the food eaten by our stock as possible, and that we should direct our energies to growing crops of the highest quality for the production of dairy products. The question of the kinds of forage crops that are best suited to New England has been fairly well answered by the tests of the past one hundred years. The degree of improvement to which these crops are susceptible has not been so clearly shown. We have reason to believe that there is still opportunity for improving the condition of dairying by making the question of the quality of the forage of prime importance in determining what we shall grow and use.

The value of the hay crop cannot be better shown than by quoting a few statistics from the last United States census reports. The census of 1890 shows the hay crop of Massachusetts to have amounted to 793,196 tons. Giving this a value of \$10 per ton, we have a total value for the crop of nearly \$8,000,000. This represents far greater value than any other of our farm crops. The opportunities for improvement in the hay crop are likewise shown in the census returns. The average yield per acre of hay in Massachusetts, according to the census of 1890, is a trifle over $1\frac{1}{4}$ tons per acre. When we consider that 3 tons per acre is not an uncommon yield under improved methods of

culture, we may see what a chance there is for improvement.

Since grass and hay can now be handled so largely by machinery, it becomes one of our most profitable market crops. The cost of production is less than for most of our larger farm crops. It is safe to estimate that, where fields are of fair size and the crop can be produced on a large scale, a crop of hay can be grown, harvested and housed at from \$8 to \$12 per acre. A fair yield of hay would not be less than $2\frac{1}{2}$ tons per acre. When hay commands a price of from \$14 to \$18 per ton in near-by markets, it becomes a far more profitable crop than any of the common grains. Dairy farmers who live near good markets will generally find it more profitable to sell their better grades of hay, to feed cheaper coarse fodders, and to supplement these by the liberal use of grain feeds.

GRASSES.

The grasses, taken collectively, form one of the largest and most widely distributed orders of plants. More than three thousand species have been described. They are found in all parts of the world, from the tropics to as far north as vegetation will thrive. The plants of this family are probably of more value to man than those of any other botanical family. They furnish practically all of the cereal foods used by man and animals, as well as most of the coarse fodder fed upon the farm. Ordinarily we think of the grasses as including only such plants as are used for hay; but all of our common grains (except buckwheat), such as corn, wheat, rye, oats, barley, rice and sorghum, belong to the same general class of plants. The grasses represent a great diversity in form and manner of growth. Some species, like the small spear grass common in lawns, grow only a few inches high; others, like sorghum and corn, are from ten to fifteen feet high; and still others, like the bamboo of the tropics, reach a height of fifty to seventy feet.

While several of the cereals, such as wheat and barley, have been cultivated from the earliest times, our common meadow and pasture grasses have been brought into culti-

vation within the past three hundred years. It is said that up to the year 1815 only three or four kinds of the common field grasses were under cultivation throughout Europe. Some of the best of our meadow grasses were discovered and first brought into cultivation in the United States, and afterwards were distributed throughout England and Europe. This is true of timothy, of orchard grass, and probably Kentucky blue-grass.

Our common grasses thrive naturally on most New England soils, — a condition which makes this region especially adapted for grazing and dairy farming. Nearly all meadow and pasture grasses grow best in a cool, moist climate. It is said that in the Swiss mountains are found the richest grazing lands of the world, while in our own country Vermont and New Hampshire furnish some of our best pastures and produce the highest quality of dairy products. In the warmer and semi-arid parts of the world most of the common grasses do not thrive well, — a condition unfavorable to the extensive development of the dairy industry in those regions.

There are about thirty different species and varieties of grasses of more or less value for use in our pastures and meadows, while perhaps eight or ten of these may be classed as quite valuable. Of the possible ten which are of considerable value, only three or four are commonly known to most farmers. While doubtless timothy, red-top, Kentucky blue-grass and orchard grass are among our best kinds, there are several other varieties that ought to be more widely known and better appreciated.

KINDS OF GRASSES.

Timothy is one of the best known of our common meadow grasses. The yields per acre are larger than for most other kinds, although the quality of the crop for dairy stock is not the best. As a grass to raise for market it has no superior. It gives a clean, bright hay, which rarely ever becomes mouldy or musty and is generally free from dust. These conditions make it a favorite with horsemen. Its chemical composition, however, shows it to have a smaller food value than many other kinds. This is due in part to

the large proportion of coarse, stemmy growth, which makes it less digestible than some of the finer grasses. When wanted for feeding dairy stock, it should be thickly sown, and, if grown with red-top or red clover, the mixture will have a much higher feeding value than the timothy alone. When cut before the blossoming period, it will usually give a fair crop of rowen. Timothy should not be depended upon for pasturage, as it will not withstand close cropping nor constant trampling by animals.

Orchard Grass. — Orchard grass is one of the best early grasses, usually being ready to harvest in this climate from June 5 to 15. It rapidly deteriorates if allowed to remain standing after the early blossoming stage. It generally gives a large proportion of coarse, stemmy growth, which is very tough and unpalatable unless harvested while young. One characteristic of the orchard grass is to send up a quick growth of aftermath, so that on well-fertilized fields two and often three crops per year may be obtained. The greatest objection to this grass is its tendency to grow in clumps or tussocks. This has been overcome by some farmers by heavy seeding and heavy manuring, or by mixing the seed with a large proportion of Kentucky blue-grass. Orchard grass is not particularly valuable as a pasture grass, for the same reasons which were given in the case of timothy.

Kentucky Blue-grass. — This is one of the most nutritious and most palatable grasses for dairy stock. It is an early grass, blossoming about with, or a little later than, the orchard grass. When used in grass mixtures, it should always be grown with early maturing grasses, as it rapidly becomes tough and woody as the season advances. It is a common mistake to use this grass in mixtures with timothy and red-top. The dried, white tops of the Kentucky blue-grass will almost invariably appear before the timothy is fully grown.

Meadow Fescue. — For growth on moist meadows, one of the best of our medium early grasses is the common fescue or evergreen grass. The stems of this grass are rather coarse, although the proportion of leafy bottom grass is very large. It should be grown with timothy, or

better with English rye grass, which is a finer variety of grass, and will help to fill up the spaces between the plants of the fescue.

English Rye Grass. — This grass occupies about the same position in England that the timothy does with us. It is not, however, as coarse and stemmy as the timothy, and, on the whole, gives a better quality of forage. It is valuable for use with coarser grasses, as it tends to fill up the spaces between these kinds. If grown with timothy, the mixture should be cut a little before the timothy reaches full bloom as the rye grass will be in blossom between June 20 and 30.

Red-top. — There are two varieties of red top, — the large or taller red-top, and the Rhode Island bent. These do not differ materially except in their coarseness and manner of growth. The taller red-top is one of our latest grasses, and is especially well suited for moist, heavy soils. Red-top and timothy make one of the best mixtures for use as a market crop. The fine red-top or Rhode Island bent is valuable for growing with the large red-top and timothy, as, owing to its fine, compact growth, it will obtain a foothold and occupy space which would not otherwise be taken. The fine red-top is also one of the best grasses for use on pastures, as it makes a firm sod, and is not injured by constant trampling by animals.

There are doubtless other grasses which would be of considerable value for use on certain soils, but those described constitute our standard sorts, and furnish us with a variety well suited for different soils. The value of the hay crop for feeding can be greatly increased by growing the clovers in connection with our common grasses. There is a general prejudice against the presence of clover in any hay offered for sale in our markets, but this need not apply to the use of hay on the farm. Hay, for almost any kind of live stock, will be greatly improved by having a certain proportion of clover in it. In discussing the value of the hay crop, therefore, it is almost necessary that we should include the clovers and some other legumes.

THE CLOVERS AND OTHER LEGUMES.

While these plants do not belong to the grass family, they constitute one of the most important groups of forage crops, both on account of their high feeding value and their effect on the fertility of soils. As a rule, hay plants contain an excess of woody fibre and starchy materials, but are relatively deficient in nitrogenous matter or protein. A one-sided ration is furnished when hay from the pure grasses is fed. The clovers and other legumes are rich in protein, and are especially valuable to use with grasses to help balance the ration. When plenty of clover is available, less of such feeds as cotton-seed, linseed and gluten meals, which are used mainly to supply protein, need be purchased. In addition to the high feeding value of clovers, they are of great value for keeping up and even increasing the fertility of the soil. The clovers belong to a class of plants which gather most of their nitrogen from the air, and much of this nitrogen goes to the soil through the manure. In addition, considerable fertility results from the decay of stubble, roots and leaves, which remain after the crop is harvested. One drawback to the successful culture of clover on many farms seems to be the lack of lime in the soil. The lime is needed, not only as plant food, but to overcome the acid condition of the soil, which is detrimental to the growth of clover. The liberal use of lime has made many of the soils of Rhode Island productive of clover, upon which it formerly "winter-killed" nearly every year. Much poor success with clover is also due to not seeding at the proper times. Clover seeded with grasses in July or the early part of August will seldom fail to produce a vigorous growth during the following fall. This will provide a good cover for the roots during the winter, and in the spring the clover will make an early start, and generally produce two heavy crops the first season. The first year the clover will predominate, while the second year the crop will be about one-half grasses, and the third year the clover will have nearly disappeared. Clover is short-lived, and the supply can be kept up only by frequent seeding. The common red clover is without doubt the

best variety for most New England conditions. On heavy, rather clayey soils, better results are often obtained with the alsike clover. The alsike is finer and more leafy, and contains considerable more protein than the common red. The crimson clover has been advocated as a valuable substitute for our common clover, but for this climate it is doubtful economy. In Connecticut it has failed to winter about three years out of five. As a hay plant, it has no advantages over the common clover. If it can be made hardy, it will prove a valuable catch-crop for green manuring, as it can be sown late in the summer, and may be ploughed under in time for planting some hoed crop the next season.

Alfalfa.—The alfalfa is a forage plant of the clover group that is very extensively grown in the Rocky Mountain and Pacific Coast regions. Although not especially well known in the East, it possesses qualities which make it well worthy of our consideration. The great drawback with the crop is its tendency, the first year, to “throw out” by the freezing and thawing weather which is so common during our winters. Wherever it has been successfully carried over the first winter, it has proven permanent. As a crop for soiling purposes, it has few if any equals. From three to four cuttings per year may be obtained, and it will often yield as high as 10 to 12 tons of green fodder per acre. It is one of the most nutritious of the legumes, giving a considerably higher percentage of protein than any of our clovers. When wanted for hay it should be cut early, even before the majority of the plants reach full bloom. Soon after the blossoming period the stems become tough and woody and are not well eaten, while if early cut, it is greatly relished by dairy stock. One difficulty in growing the crop in the east seems to be due to the general belief that it is suited to poor soils, and will grow without the addition of much manure or fertilizer. This is a great mistake, as the crop needs careful culture the first year. The land should be heavily seeded, at the rate of 15 or 20 pounds per acre, and well manured with stable manure or a complete fertilizer, so as to induce as vigorous a growth as possible the first season. The crop should also be cut three times during the first summer, in order to induce a vigorous

root growth. The chief aim the first season should be to produce plants with strong, vigorous roots, which will attain such a size and depth as will not allow of their being disturbed during the following winter. If successfully carried through the first winter, the roots will become sufficiently strong and vigorous the second year to make the crop practically permanent. After the first year or two, good crops may be grown mainly by the use of mineral fertilizers. This crop should not be grown on heavy, compact soils, nor where there is liable to be standing water on the soil during any portion of the year.

*Composition of the Hay of Grasses and Legumes, and Silage Crops.**

	Dry Matter (Per Cent).	DIGESTIBLE NUTRIENTS.		
		Protein (Per Cent).	Ether Extract (Per Cent).	Carbo- hydrates (Per Cent).
<i>Hay of Grasses.</i>				
Timothy, ...	86.8	2.8	1.4	43.4
Orchard grass, ...	90.1	4.9	1.4	42.3
Red-top, ...	91.1	4.9	1.0	46.9
Kentucky blue-grass, ...	78.8	4.8	2.0	37.3
Meadow fescue, ...	80.0	4.2	1.7	43.3
Oat hay, ...	91.1	4.3	1.5	46.4
Rowen hay, ...	83.4	7.9	1.5	40.1
<i>Hay of Legumes.</i>				
Red clover (common)	84.7	6.8	1.7	35.8
Alsike clover, ...	90.3	8.4	1.5	42.5
Alfalfa, ...	91.6	11.0	1.2	39.6
Soja-bean hay, ...	88.7	10.8	1.5	38.7
<i>Silage.</i>				
Corn, ...	20.9	.9	.7	11.3
Sorghum, ...	23.9	.6	.2	14.9
Grass, ...	32.0	1.9	1.6	13.4
Clover, ...	28.0	2.0	1.0	13.5
Alfalfa, ...	27.5	3.0	1.9	8.5
Soja beans, ...	25.8	2.7	1.3	8.7
Corn and soja beans, ...	24.0	1.6	.7	13.0

* From "Feeds and Feeding," by Prof. W. A. Henry.

COMPOSITION OF GRASSES.

The value of hay as indicated by the composition is dependent upon two factors, — the digestibility, and the proportion of the various food nutrients which it contains when calculated to a digestible basis. The feeding value is regulated largely by the percentage of digestible protein which the hay contains. From the table it will be seen that of the pure species of grasses timothy contains the lowest percentage of digestible protein, while orchard grass, red-top and Kentucky blue-grass are the richest in protein, containing about 5 per cent, against a little less than 3 per cent in the case of timothy. From this table it will also be seen that rowen hay ranks with the clovers in composition. This is due to the fact that young, immature grasses always contain a higher percentage of protein than those which are fully grown. The high feeding value of the clovers is also due to the high percentage of protein which they contain. Early cut clover will contain about twice as high a percentage of protein as our common grasses. For the same reason clovers and other legumes, when used for silage, have a much higher feeding value than the silage of corn, sorghum, or grass.

SEEDING GRASS LANDS.

There is much difference of opinion among good farmers with regard to the best time for seeding grass lands, and as to the advisability of seeding the crop alone or in connection with some of the grains, as rye, wheat or oats. The use of a “nurse” crop in which the grass is to grow the first season is highly recommended by many. The claim is made that grass makes but little growth the first season, anyway, and that it is almost sure to become well established after the grain or “nurse” crop is harvested, and thus a good crop will be secured the following year. The drawback in seeding in connection with grain lies in the fact that the grain occupies the ground to the disadvantage of the grass until the grain crop is harvested, and in many cases severe drouths, following close after the harvesting of the grain, will destroy the young, tender grass plants.

Again, if the grain crop happens to lodge in places, the grass is almost sure to be killed on such spots. Within the past few years many successful farmers in Connecticut have adopted the practice of seeding their grass lands in the latter part of July or the first part of August, and almost invariably good results have been obtained. In case the season is dry, the seed should be covered more deeply than usual, and the first rains will be almost sure to cause it to germinate. By seeding not later than the middle of August, the crop, having full use of the soil, becomes well established before cold weather, and the amount of herbage is sufficient to protect the roots from the frosts of winter.

It is a common mistake, in seeding grass lands, to put too many kinds together. This seems to be done with the thought that, if one or more kinds fail, others will grow, and thus the land will be occupied. It is not uncommon to find grass mixtures advertised which contain species varying in time of blossoming from early in June to near the middle of July. In attempting to grow mixtures of this kind some varieties are sure to be harvested when in a tough, woody condition. At the same time, it is wise to grow a sufficient variety of grasses on different fields so as not to crowd the haying season into a short period of time. Of the many valuable varieties from which selections can be made, it is possible to prepare mixtures of kinds that will bloom within a short period of each other. Such grasses as Kentucky blue-grass, orchard grass and tall meadow oat grass all come into bloom between June 5 and 15, and these grasses will make a good mixture for early harvest. The tall meadow fescue and English rye grass may be classed as medium early grasses, being in the best condition for harvest between June 20 and 30; while timothy and the two varieties of red-top, the common red-top and the Rhode Island bent, may be classed as late grasses. The time when the crop will be ready to harvest will also depend considerably on the season and the kind of soil. On moist, cold soils all grasses will be later in coming into bloom than the same varieties would on warm soils. There are no grasses that thrive better on moist, cold lands than the two varieties of red-top, and on such soils these can be

grown to advantage without any admixture, and can be harvested as late as the middle of July and still be in prime condition.

HARVESTING THE GRASS CROP.

In these days of improved machinery it is important to handle the hay crop with as little hand labor as possible. In the days of our grandfathers there was some excuse for the haying season lasting until the first of September; but to-day, barring exceptional wet seasons, there is little reason for continuing the haying later than the middle of July. A common mistake made by our ancestors was in drying the hay until it was crisp and brittle. There was perhaps more necessity for this in olden times, when the barns were slowly filled, as sufficient hay was not gotten in at one time to create the fermentation needed to dry out the mow. If the hay is partially dried in the field and is entirely free from adhering moisture, and a large amount is stored together at one time, the greater part of the drying and curing can be left to take place in the barn.

One of the most common errors is in allowing the hay crop to become overripe. This not only reduces the digestibility of the crop, but also greatly lessens the palatability, — a fact too often overlooked in the feeding of dairy stock. It would be economy, in case a large amount of hay is to be harvested, to cut part of it even before the crop is fully grown, rather than to allow any considerable portion of it to become tough and woody by standing until the seed is formed. Late-cut grass is not only less digestible and less palatable than that cut while in bloom, but also requires a greater amount of labor on the part of the animal to make the food nutrients available. The labor performed in the effort to make available this tough, woody material requires energy that otherwise might be available for building up direct animal products, such as meat and milk.

The principal changes which take place in grass as it advances toward maturity are the increase in the proportion of crude fibre and the storage of food materials in the seed, neither of which conditions add to the feeding value of the fodder. If the seed is allowed to develop, most of it is

lost in the harvesting; or, if retained, it is too small and hard to be acted upon by the digestive system of the animal. The increase in the crude fibre helps to encase and lock up the other food nutrients which are of greater value, and which might have been available if the crop was cut before the crude fibre had so largely developed. The difference between the digestibility of hay cut in different stages of growth has been clearly shown in experiments by Dr. Jordan while at the Maine Experiment Station. From these I have selected five which show the contrast between the early and late cut timothy hay. Two of these may be classed as early cut and three as late cut. The difference in favor of the early cut is 13 per cent for the protein, $5\frac{1}{2}$ per cent for the fat, 7 per cent for the nitrogen free extract and $11\frac{1}{2}$ per cent for the fibre. In other words, the early-cut grass averaged about 10 per cent more digestible than the late cut.

Digestibility of Timothy Hay, Early and Late Cut.

	Organic Matter (Per Cent).	Protein (Per Cent).	Fat (Per Cent).	Nitrogen Free Extract (Per Cent).	Fibre (Per Cent).
Early cut, . . .	61.0	59.0	57.0	64.0	59.0
Full bloom, . . .	67.0	60.0	52.0	72.0	62.0
Past bloom, . . .	56.0	45.0	35.0	61.0	51.0
Two weeks past, . . .	52.0	45.0	55.0	59.0	43.0
Late cut, ...	59.0	50.0	58.0	64.0	53.0
Average of two "early cut."	64.0	59.5	54.5	68.0	60.5
Average of three "late cut."	55.5	46.5	49.0	61.0	49.0

GRASSES FOR PASTURES.

In growing grasses for pasturage, entirely different conditions exist from those which exist where grasses are to be grown for hay. A fresh, vigorous growth is needed throughout the entire season. This cannot be obtained where only one or two kinds are grown. Some grasses start into

growth much earlier than others. Some will withstand the effects of the heat of summer, and some will make a luxuriant growth in the cool of the fall. A variety of forage is also important for our herds during the grazing season. Hence what we have said with regard to growing a number of kinds together, which will blossom inside of a short period of time, does not apply to the growth of grasses for pasture. Then, again, varieties which are best adapted for meadows are sometimes not well suited for pastures, because they will not withstand close cropping nor the continuous trampling of animals. Timothy, although one of the best of our meadow grasses, is among the poorest for use in pastures. When closely fed down by animals, it dies out, and soon becomes replaced by the finer varieties. Grasses which will make a close turf, such as Kentucky blue-grass and the fine red-top, are the best for use in pastures, and should make up the greater proportion of such mixtures. There is also a choice in the clovers for pasture mixtures. The common red clover will not long endure close feeding by animals, but the small white clover makes a low, mat-like growth, which is quite permanent, and which furnishes a most nutritious pasturage. From 5 to 8 pounds per acre of the seed of this clover should be used when seeding for pasturage.

MISCELLANEOUS FODDER CROPS.

Owing to a frequent shortage of hay, due to drouths or other causes, and the high market value of the crop, it becomes important that we should provide as much supplementary fodder as possible for our herds. There are a number of substitutes for the more marketable grades of hay, which have fully as high a feeding value, but which do not find ready sale in the markets. These should be grown and used in place of hay as far as possible.

Fodder Corn.—There is no crop that is well suited to New England which will give so large an amount of total food materials for our herds as corn, and there is no crop so cheaply grown in proportion to the food materials which it supplies. With the aid of the silo, it provides us with a class of fodder that is especially well suited to the needs of

our dairy herds during the winter season. There are other crops that can be used in the silo, but none which are better suited for preservation in this form than corn. Its advantages are: (1) in the large amount of food nutrients which can be produced per acre; (2) in the readiness with which the material can be preserved in the silo, with comparatively little loss; and (3) the adaptability of the crop to nearly all parts of New England. Experience has shown that the first advocates of the silo had many visionary theories regarding its advantages. Many of these theories experiments and practical experience have completely overturned. We realize to-day that we can get no more out of the silo than we put into it. In fact, we realize that we must get less; that, instead of the material having a greater value when it comes out than when put in, there are constant losses in the food nutrients during the ensilaging process. We have learned that, just as corn fodder from partially grown or immature corn, when fed green, has very little feeding value, so the same corn when taken from the silo has a low feeding value. Well-matured corn fodder, with most of the corn hard and ready to husk, is in the best condition for storing in the silo. In order to get the proper degree of maturity, care should be taken to select varieties which are well suited to the climate, and to choose those kinds which will give a large proportion of grain, rather than an immense growth of stalks and leaves.

Oats and Peas. — Oats have long been grown and highly appreciated as a forage crop. In recent years we have learned that a mixture of oats and peas will furnish a better quality of fodder. Fully as large if not larger yields may be obtained from the mixed forage, while the feeding value is much higher than that of oats alone. The crop should be sown as early in the spring as it is possible to plough and prepare the soil thoroughly. Two bushels of oats with one bushel of the Canada field peas makes a good proportion. The peas should be ploughed under about a week before the oats are sown. By sowing in this way, both will grow and develop about together. The crop may be used either for feeding green or may be made into hay for winter feeding.

Hungarian and Millet.—There are several varieties of Hungarian grass and millet which are quite valuable for forage. The Hungarian and one or two of the smaller millets are most commonly grown for hay. One great advantage in these crops is the fact that they can be sown as late as the middle of June, or late enough so that the prospects for a poor or a good hay crop can be safely estimated. The millets are rapidly growing crops, and should always be supplied with plenty of available plant food, and especially with an abundance of nitrogen. They will often make their growth in from nine to ten weeks, and should always be cut early, to prevent their becoming tough and woody.

Soja Beans.—The soja bean is a leguminous plant, worthy of our consideration either for use as a forage crop or for the production of seed. It is well suited to all of the southern half of New England, and will produce from 10 to 12 tons of valuable fodder per acre. Like all of the legumes, it is rich in protein. The seed is especially rich in this nutrient, containing nearly as high a percentage as cotton-seed meal. Experiments made at the Hatch and the Kansas stations tend to show that the seed has a high feeding value for dairy stock, and that it produces no injury to milk or butter. The crop may be harvested before the seeds are fully matured, and fed as a soiling crop, or it may be mixed with corn and put into the silo. Better results have generally been obtained by mixing the highly nitrogenous leguminous crops, such as the soja bean or the clover, with corn when filling the silo, than by ensilaging them alone. The leguminous fodders, when preserved in the silo, seem to produce a different kind of fermentation from the more starchy materials, such as corn or other cereals. The silage often has a strong, disagreeable odor, which sometimes affects the quality of the products. Where the soja beans or clover have been mixed with corn at the rate of two parts of corn to one part of the other crop, no injurious effects have been observed. If the soja beans are planted about the last week in May, the crop will be in the right condition for harvesting with the corn early in September. One condition, however, must be provided if good crops are to be expected. The bacteria which aid the plant

in securing nitrogen from the air do not seem to exist naturally in our soils. Whenever we have grown the crop on new soil, light yields of pale yellow forage have always resulted unless we have taken the precaution to inoculate the soil from a field where soja beans had been previously grown, and where the nodules had existed upon the roots. The presence of these little nodules or root tubercles is directly associated with the acquisition of the atmospheric nitrogen, and wherever these root nodules are absent, practically no nitrogen is taken from the air. At first thought it may seem like a difficult matter to inoculate a large field; but experiments have shown that, where about 1,000 pounds per acre of the soil which contains the proper germs are sifted into the drill with the seed, the root nodules will appear in abundance by the time the plants are six inches high.

Barley and Peas. — It is often desirable to have a forage crop suitable for soiling or for pasturage late in the fall, when our ordinary pastures give but little feed. One of the best crops for this purpose is a mixture of barley and peas. This crop can be fed throughout the entire month of October, and will often remain green and succulent well into November. The crop needs to be sown as early as the first of August. The peas should be ploughed under, while the barley should be sown on the surface, and carefully harrowed in a few days later. Owing to the difficulty in drying the crop during the short days of the fall, it is not a good crop to use for making into hay. Many fields which have grown a crop of rye or oats might be sown to this crop immediately after the first crop is harvested. The barley and peas would serve the double purpose of keeping the land occupied and preventing the waste of nitrogen, and also provide a considerable amount of forage. If not wanted for feeding green, the crop could be pastured with good results.

EFFECT OF NITROGENOUS FERTILIZERS ON GRASSES AND OTHER FODDER CROPS.

One of the first lines of work undertaken by the Storrs Station after its organization in 1888 was a study, by means of field experiments, of the effect of nitrogenous fertilizers

on the yield and composition of corn, oats and mixed grasses. These experiments were continued through a period of several years. A few years later, experiments of a similar nature, but on smaller plots, were started with pure species of grasses. In these experiments the plots were so small that no attempt was made to study the effect of the fertilizer on the yields, but the crop was carefully sampled, and the effect of the fertilizer on the percentage of nitrogen and protein was determined.

The field experiments with mixed grasses were what are commonly known as "special nitrogen experiments." The general plan was to lay out a series of plots, all of which, except two or three plots without any fertilizer, were supplied with uniform quantities of mineral fertilizers. In addition to this, the fertilized plots had varying quantities of nitrogen. The quantity of nitrogen varied on different plots from nothing to 25, 50 and 75 pounds of actual nitrogen per acre, in the form of nitrate of soda, and the same amounts in the form of sulphate of ammonia. These experiments with mixed grasses were continued through two years, and the results, as shown in the yields, are of considerable interest, as indicating the striking way in which grasses respond to nitrogenous fertilizers. All of the fertilized plots were supplied with liberal quantities of mineral fertilizers (phosphoric acid and potash). The yields, where mineral fertilizers only were used, were but very little better than where no fertilizer was applied. The increase where the nitrogen was applied nearly always corresponded with the amount of nitrogen used, whether the nitrogen was from nitrate of soda or sulphate of ammonia. The increase, however, was not as great where the larger quantities of nitrogen were applied. The best financial returns, an average gain of \$3.60 per acre, were obtained from the use of 320 pounds of nitrate of soda per acre, in addition to the mineral fertilizers.

In the following table the hay is valued at \$10 per ton to correspond with present prices, and the cost of the fertilizer is estimated from the prices for the various ingredients used in the valuation of fertilizers by the New England stations for 1898. Where mineral fertilizers were used, without the

addition of nitrogen, there was a decided financial loss, while in all cases except one where nitrogen was used with the mineral fertilizers there was a financial gain. The increase in yield obtained from the two forms of nitrogen was nearly the same, although the financial gains were considerably better with nitrate of soda than with sulphate of ammonia. The smaller gain is accounted for in part by the higher cost of the sulphate, the nitrogen in this form being reckoned at one cent per pound higher than that from the nitrate of soda.

Yields and Value of Increase in Experiments with Nitrogenous Fertilizers on Mixed Grasses (Averages for Two Years).

No. of Plot.	FERTILIZERS.	Weight of Fertilizers.	Cost of Fertilizers.*	Total Crop (11 Per Cent Water).	Increase over Nothing Plots.	Value of Increase at \$10 per Ton.	Net Profit or Loss (-).
0	Nothing, ...	lbs. -	-	lbs. 1,821	lbs. -	-	-
7	Mixed minerals, as No. 6, ... Nitrate of soda, 25 pounds nitrogen, ...	480 } 160 }	\$8 99	4,077	2,044	\$10 22	\$1 23
8	Mixed minerals, as No. 6, ... Nitrate of soda, 50 pounds nitrogen, ...	480 } 320 }	12 24	5,200	3,167	15 84	3 60
9	Mixed minerals, as No. 6, ... Nitrate of soda, 75 pounds nitrogen, ...	480 } 480 }	15 49	5,157	3,124	15 62	0 13
6a	Dissolved bone-black, mixed minerals, ... Muriate of potash, mixed minerals, ...	320 } 160 }	5 74	2,777	744	3 72	-2 02
10	Mixed minerals, as No. 6, ... Sulphate of ammonia, 25 pounds nitrogen, ...	480 } 120 }	9 24	3,804	1,771	8 86	-0 38
11	Mixed minerals, as No. 6, ... Sulphate of ammonia, 50 pounds nitrogen, ...	480 } 240 }	12 74	4,807	2,774	13 87	1 13
12	Mixed minerals, as No. 6, ... Sulphate of ammonia, 75 pounds nitrogen, ...	480 } 360 }	16 24	5,136	3,103	15 52	0 72
00	Nothing, ...	-	-	2,244	-	-	-
6b	Mixed minerals, as No. 6, ...	480	5 74	2,876	843	4 22	1 52

EFFECT OF NITROGEN ON THE PROTEIN OF THE CROP.

In connection with the field experiments on the yields and financial results from the use of nitrogenous fertilizers, a study was also made of the effect of the fertilizer on the

* The cost of the fertilizer is based upon the station valuation for nitrogen, phosphoric acid and potash for the year 1898, — nitrogen from nitrate of soda being 13 cents per pound, from ammonia compounds 14 cents, potash as muriate 4½ cents, and soluble and available phosphoric acid 4½ cents.

composition of the crops. In the experiment with mixed grasses there was a small proportion of clover on all of the plots, but in most cases not enough to materially lessen the value of the comparative results. In the case of the plots supplied with mineral fertilizers only, however, the proportion of clover was much larger than on the other plots, and the percentage of protein in the crop from these plots was correspondingly high. In judging of the effect of nitrogen as compared with mineral fertilizers, it will be necessary to take this into consideration. In one of the experiments, for a single season, samples were taken of the pure grasses only on one of the mixed mineral plots. It was found that, where the clover was excluded from the sample, the amount of protein was 7.2 per cent; while for a mixed sample, which was an average of the entire growth on the plot, there was nearly 11 per cent. If we were to assume that the average percentage of protein found in the grasses (exclusive of clover) on the mineral plots was about 7 per cent, the comparison of the results would doubtless be more accurate. With 25 pounds of nitrogen the percentage of protein was 7.75 per cent, while with 50 pounds it was increased to 8.5 per cent, and with 75 pounds to 9.4 per cent. The percentages of protein obtained in similar experiments with oats, corn and cow-pea fodder are also given. The influence of nitrogen on the protein of the seed of corn and oats was even more striking than on the straw and stover; but the results on the seed have been omitted, in order to confine our discussion to fodder articles. In the case of oat straw, the mineral fertilizers alone gave a slightly higher percentage of protein than where 25 pounds of nitrogen were added. This may, perhaps, be accounted for by the fact that the number of experiments upon oats was fewer than with most of the other crops. The protein in the straw increased quite rapidly with the use of 50 and 75 pounds of nitrogen per acre. In the corn stover there was a gradual increase in the percentage of protein, corresponding fairly regularly with the increase in the amount of nitrogen used. In the case of the cow-pea fodder, the percentage of nitrogen on the mineral plots was larger than on

any of the nitrogen plots except where 75 pounds of nitrogen per acre were used. This would seem to indicate that the effect of nitrogen in the fertilizer on the percentage of protein in the crop is not nearly as marked with the legumes as with the grasses and cereals.

Effect of Nitrogenous Fertilizers on the Percentage of Protein in Mixed Grasses, Oat Straw, Stover and Cow-pea Fodder.

KIND OF FERTILIZER.	KIND OF CROP.			
	Mixed Grasses, Protein (Per Cent).	Oat Straw, Protein (Per Cent).	Corn Stover, Protein (Per Cent).	Cow-pea Fodder, Protein (Per Cent).
No fertilizer, ...	7.29	7.39	6.91	18.64
Mineral fertilizzer, ...	7.82	5.04	5.15	18.25
Mineral fertilizer + nitrogen, 25 pounds per acre.	7.75	4.89	5.52	18.19
Mineral fertilizer + nitrogen, 50 pounds per acre.	8.46	5.25	5.62	17.75
Mineral fertilizer + nitrogen, 75 pounds per acre.	9.40	6.02	6.79	19.55

The relative effect of nitrogen upon the yields per acre of dry matter and protein in the mixed grasses is shown in the following table, and for comparison another table is given, showing the relative effects on corn and stover. In these tables the plots having corresponding amounts of nitrogen have been combined, whether this nitrogen was from nitrate of soda, sulphate of ammonia or dried blood. In the case of the mixed grasses there was an increase of about 1,000 pounds of dry matter for every 25 pounds of nitrogen used. The percentage of increase obtained on the nitrogen plots over the mineral plots shows that the relative gains in protein were much larger than for the dry matter. This indicates that the protein was increased relatively faster than the other food constituents of the crop, and the same is true for the corn and stover.

Relative Yields of Dry Matter and Protein in Hay of Mixed Grasses.

	Dry Matter (Pounds).	Protein (Pounds).	PER CENT OF IN- CREASE OF NI- TROGEN PLOTS OVER MINERAL PLOTS.	
			Dry Matter.	Protein.
No fertilizer, ...	1,675	121	-	-
Mineral fertilizers, no nitrogen, ...	2,368	195	-	-
Mineral fertilizers + nitrogen, 25 pounds per acre.	3,240	248	37	27
Mineral fertilizers + nitrogen, 50 pounds per acre.	4,202	365	77	87
Mineral fertilizers + nitrogen, 75 pounds per acre.	4,458	432	88	122

Relative Yields of Dry Matter and Protein in Corn and Corn Stover.

	CORN.				CORN STOVER.			
	Dry Matter (Pounds).	Protein (Pounds).	PER CENT OF INCREASE OF NI- TRO- GEN PLOTS OVER MIN- ERAL PLOTS.		Dry Matter (Pounds).	Protein (Pounds).	PER CENT OF INCREASE OF NI- TRO- GEN PLOTS OVER MIN- ERAL PLOTS.	
			Dry Matter.	Pro- tein.			Dry Matter.	Pro- tein.
No fertilizer, ...	1,064	118	-	-	1,254	86	-	-
Mineral fertilizers, no nitrogen, ...	1,580	160	-	-	1,876	93	-	-
Mineral fertilizers + nitrogen, 25 pounds per acre.	2,132	228	35	43	2,149	118	15	27
Mineral fertilizers + nitrogen, 50 pounds per acre.	2,611	290	65	81	2,271	136	21	46
Mineral fertilizers + nitrogen, 75 pounds per acre.	2,690	320	70	100	2,372	166	26	78

EXPERIMENTS WITH PURE SPECIES OF GRASSES.

The increase in the protein of the crop, due to the use of nitrogenous fertilizers, is even more strikingly shown in the experiments on the pure species of grasses. These experiments have been continued through a period of seven years on the same plots. The plots were so small that no attempt was made to study the effect of the fertilizer on the yields, but samples for analysis have been taken each year at the time of harvesting, which usually was at or very soon after the blossoming stage. In these experiments it became

necessary to omit the plots with 50 pounds of nitrogen per acre. For the timothy the percentage of protein with mineral fertilizers only was 7.25 per cent, while with 75 pounds of nitrogen it was a little over 9 per cent. With the meadow fescue the percentage of protein was 7.25 per cent with mineral fertilizers, but with 75 pounds of nitrogen it was a little over 12 per cent. In the case of orchard grass mineral fertilizers gave 8.16 per cent, and 75 pounds of nitrogen gave 12.4 per cent of protein; while with red-top and tall meadow oat grass, although the experiments were fewer, a similar increase in the percentage of protein may be noticed.

Effect of Nitrogenous Fertilizers on the Percentage of Protein in Pure Species.

KIND OF FERTILIZER.	KIND OF GRASS.				
	TIMOTHY.	MEADOW FESCUE.	ORCHARD GRASS.	RED-TOP.	TALL MEADOW OAT GRASS.
	Protein (Per Cent).	Protein (Per Cent).	Protein (Per Cent).	Protein (Per Cent).	Protein (Per Cent).
No fertilizer, ...	7.89	7.28	8.44	6.89	7.83
Mineral fertilizer, no nitrogen, .	7.25	7.24	8.16	6.60	7.50
Mineral fertilizer + nitrogen, 25 pounds per acre.	7.34	8.81	9.50	7.27	9.70
Mineral fertilizer + nitrogen, 75 pounds per acre.	9.07	12.05	12.37	9.50	12.63

The Meaning of the Experiments.—Grasses differ from many other crops in the readiness with which they respond to the use of nitrogenous fertilizers. While clovers and other legumes seem to be able to gather much of the nitrogen they need from natural sources, the true grasses must be supplied with nitrogen in the manure or fertilizer, in order to give much increase in yield. Thus there is a two-fold value in the experiments. In the first place, they show that the grasses call for the use of nitrogenous fertilizers, and that very little increase of crop is to be expected from mineral fertilizers alone. They indicate that where the farmer uses stable manure, which contains relatively large quantities of nitrogen, on his grass crop he is following a wise practice, and that by the liberal use of manures rich

in nitrogen he may increase the crop two or three fold over what would be obtained where no nitrogen or other fertilizer was used. They indicate, further, that the increase in yield is not the only advantage obtained from the use of nitrogen in the fertilizer. As protein is the most valuable of the food nutrients contained in feeding stuffs, it becomes important that the farmer should adopt every means available for increasing the supplies of this material upon the farm. This he may do to quite a degree by the use on the grass lands of manure from well-fed stock, or by the purchase and use of nitrate of soda, sulphate of ammonia, tankage, dried blood, fish waste or other forms of nitrogenous fertilizers. The percentage of protein in the crop may thus be increased as much as three to five per cent above what is obtained where no nitrogen is used as fertilizer.

SUMMARY.

In summarizing the subject discussed in this paper, we would call attention especially to the following points:—

First.—The grasses constitute one of the most important families of plants, furnishing more food of value to man than any other order. The need of improvement in the hay crop is shown by the small yields per acre, as indicated in the census statistics, the average yields per acre in New England being a little over one ton. Grass is a profitable money crop when hay sells at from \$14 to \$18 per ton in near-by markets. The better grades of coarse grasses are usually more profitable to sell than to feed to dairy stock at ruling prices for dairy products.

Second.—The grasses should be grown with the clovers, to produce hay of high feeding value. The clovers are of more value as food for the production of milk, can be more economically grown than the true grasses, and will improve the fertility of the soil. Hay with a considerable proportion of clover in it makes a better balanced ration than hay from the pure grasses. A saving can be made in the use of the nitrogenous grain feeds when plenty of clover is available.

Third.—Greater care needs to be exercised in the selection of the kinds of grasses to be grown together. There

is a tendency to grow too many kinds in one mixture, without regard to the time of blossoming of each. In growing grasses for hay only kinds which bloom within ten days of each other should be grown together.

Fourth. — In making grass-seed mixtures for pastures, kinds should be selected which will produce a close, compact turf, and give a variety of forage throughout the season. A considerable number of kinds may be wisely grown together on all pasture lands.

Fifth. — Hay, to be of highest value for feeding dairy stock should be harvested early. Late-cut hay is not only less palatable and less digestible, but requires extra labor on the part of the animal to make the food nutrients available. The extra energy used in the work of digesting tough, woody fodders lessens the available energy for building up animal products.

Sixth. — Great improvement in the grass crop is possible by the liberal use of nitrogenous manures and fertilizers. Nitrogen especially favors the growth of the true grasses. Not only can the yields be markedly increased by its use, but the composition, and consequently the feeding value, is considerable enhanced. In some recent experiments, by the liberal use of nitrogen in the fertilizer, the percentage of protein has been increased two to four per cent over that obtained where no nitrogen was used.

Seventh. — Owing to the high market value of hay in many localities, substitutes, mainly in the form of annual fodder crops, can be more economically used in feeding dairy stock. Doubtless the best of these crops for Massachusetts conditions is corn fodder, — especially when grown to be used as silage. Other fodder crops of high value are oats and peas, the millets, Hungarian grass, alfalfa, barley and peas, and soy beans.

The CHAIRMAN. There is now an opportunity for questions.

Professor BROOKS. Professor Phelps will agree with me that a person in one locality cannot estimate the value of a forage crop of any sort for another locality; and it seems to me, as I have worked in this locality, that it is well for

me to add a word or two to what he has said concerning some of the crops he has mentioned. Concerning the varieties of grass of which he has spoken, I should agree with him in general in his estimate of their worth, — I am speaking now of the true grasses. I want to call attention to one point, doubtless well known to him, but which he did not mention; and that is, the difficulty in getting good seed of the uncommon kinds of grass. That is one of the chief obstacles to the extension of their use. One of the trustees of the college recommended a seedsman to me as a man of rather unusual reputation for honesty, and I sent to him for some orchard grass seed. Almost all the seed was chaff and worthless weeds. This man did not mean to cheat me, I know, for he did not gain anything. There are a great many seeds that resemble the orchard grass seed in size and general appearance, concerning which seedsmen themselves undoubtedly could testify. I think you usually get the rye grasses true to name, because they are very productive of seed. The seedsmen can make a profit on them. Orchard grass seeds rather sparingly; it has not much seed, so there is a tendency to fraud in this kind of seed.

The English rye grass, of which he spoke, seems to be a very good grass the first year, but it is not a grass which I would recommend to you for the reason that it is not hardy. It is not likely to last more than a year or so.

Italian rye grass is, as a rule, still more short-lived. It may be of possible value to use in the same way that we use oats, — to cut as a forage crop for one year. There is a good deal of evidence in our experience to show that, if you seed good land to this grass in the latter part of July or any time up to the middle of August, you will get a good heavy crop of valuable hay which you can cut probably before the middle of June, — from the first to the middle of June. But, after having cut this grass one year, there is great danger that it may die out before another year.

Concerning mixtures of seeds, I should agree with the position taken by the speaker in almost all points. I do not think we should limit the number of varieties quite so narrowly. I should put in a few more.

Concerning the best of all forage crops, I want to call attention to one point which has been in my mind, and particularly this morning, when the subject was as to how we should meet the western competition. There are in this audience some farmers who have not a silo. There are more who have. I want to call the attention of those who have not one to the tremendous advantage those who have a silo have over them. Experiments carried on in New Jersey a year or two ago show very startling results. They grew fifteen acres of corn, and I think they allowed one-third to ripen; they cut it, shocked it and husked it; in due time they shelled it, ground the corn and saved the fodder and fed the meal and the fodder to one set of cows. The other portion, ten acres, was put into the silo, having been cut at the same time. It was fed in that shape to other cows. The difference was this: the corn put into the silo from a given area gave twelve and a fraction per cent more milk than corn from the same field, grown in the same way in every respect, shocked, husked, shelled and fed in the shape of dry stover and meal. The increase in butter was ten and a fraction per cent, and the difference amounted to no less than \$10 per acre in favor of the silo. Can those of you who have no silo afford to try to make milk or butter another year without one? I do not think you can.

Now, just a word concerning some of the forage crops which Professor Phelps has mentioned. Alfalfa has been mentioned. We have been experimenting with it in a small way, but as yet without much success. We have sowed it in drills close together and carefully hand-hoed it and hand-weeded it for two years, and more in one experiment, and still it did not produce much. It has been subject to a rust or blight that injured it seriously and cut down the yield. I know it to be an extremely valuable forage crop, and I hope many farms will be found in Massachusetts where it will thrive; but my experience leads me to say, without intending to discourage your trying it, "Go rather slowly at the beginning, until you find that it succeeds well on your soil and under your conditions."

Concerning the soy bean, I want to emphasize what Professor Phelps has said. It will have a future in this coun-

try. I was in Washington a week or two ago and met Professor Scribner, who concerns himself with these crops, and he told me that he considered this one of the most valuable introductions of recent times. He went further, and, after emphasizing it as a forage crop, said he believed it was going to prove to be an immensely valuable food product for the human family. The soy bean is absolutely, without any exception, the richest known vegetable product. It is almost as rich as meat. It contains no less than 36 to 40 per cent of the flesh formers, and 18 to 20 per cent of fat. No doubt we will learn to use it. I do not eat it, but I know it is capable of being made into a palatable and excellent food. The Japanese, among whom I found it, do eat it. You will be amused at one way in which I was introduced into its use. I attended a wrestling match, — it is a great national sport in Japan, — and I was shocked to see people around with beans on the vines, eating them apparently with great relish. I said to myself, “What can these people be made of to be eating raw beans in this way.” I learned afterwards that they had been boiled in the pod. A delicious and nutritious sauce is made from these beans, from which the name “soy” originated. Let me restate: I believe the soy bean has a future as a forage crop and also as a human food.

Concerning the necessity of having the little “bugs” which cause the growth of nodules on the roots, I would ask you to look at the photographs which you will find on the table in the rear of the hall, showing the growth with and without the nodules. The speaker says you must send away and get the seeds with which to inoculate your field on which you plant the soy bean. That may be the case, but it is not absolutely necessary. It may not have many nodules the first year, but the next year plant it in the same field or one adjoining and you will have more, and the next year repeat, and you will have yet more; and after a while you will have the germs all through the soil, just as you have an abundance of the nodules on the clover. I brought the first seed of the soy bean from Japan. I had only a little, — half a pint or so. I did not know anything about these nodules and the bacteria which cause them. It was

just before the discovery was made. The seed I brought was from a crop that was pulled up. The seed we send out from the college is produced in that way. We pull the crop, and I think you will get the bacteria in most cases where a crop is harvested in that way.

Professor PHELPS. I can do just as you have said, and have done it, but it was a good deal cheaper for me to send to you and get the seed and microbes.

Professor BROOKS. This year we have some soil that we are anxious to give away, if you will pay the freight. We have raised a large amount of seed of the soy bean. We are threshing it, and are getting a tremendous amount of this dust in sweeping the floor; and if any of you want to try this crop, I want to announce that we shall be glad to send you a bagful of this material that you can scatter over your field as you would a precious fertilizer. It is right from the threshing floor.

QUESTION. Which is better to feed green, corn or barnyard millet?

Professor BROOKS. If I had to make a choice between the two crops to feed green, I do not know which I should take, but I think the millet. Mr. Clemence of Southbridge told me last year that he raised thirty-five tons of millet to the acre. I asked him if he weighed the whole of it, and he said he took a few square rods and calculated the whole from that, so I am a little doubtful whether he got thirty-five tons to the acre. I know we have raised twenty tons, weighing every load as it went into the barn. In changing the feed of cows from corn to millet, the herd of cows immediately commence to increase in the amount of milk. If we change from millet to corn, the change is opposite. The cows prefer the millet. I do not recommend millet for dry land. It is a crop for strong, heavy soil, and it ought to be sowed thinly. Many make the mistake of sowing a bushel or so to the acre. That is nearly four times too much. Twelve quarts is enough, evenly distributed. You will get a better crop with this amount than you will with more. The mixing of soy beans with millet I heartily endorse. It is a splendid silage. It would generally be best, no doubt, to use the silage moderately. I do not

recommend keeping a cow wholly on this silage ; but as far as you want to use it it is a tolerably well-balanced and very palatable food, which has a good effect upon the milk.

QUESTION. Have you ever used barn-yard millet as a hay?

Professor BROOKS. Yes ; we have made it into hay, but it takes time and good weather. I think it makes a good, palatable hay. Horses eat it as readily as they eat timothy, and I have no doubt it is more nutritious. Because of the length of time it takes to make it, I cannot urge it upon the farmers as a hay crop. Perhaps I should call attention to another point, and that is, the value of millet as a grain crop. This millet gives us almost invariably about seventy-five bushels of seed per acre on land that would bear about sixty bushels of corn, perhaps.

QUESTION. How much does a bushel weigh?

Professor BROOKS. A bushel weighs thirty-five pounds. It comes, therefore, in its weight close to oats ; and I have been strongly impressed with the fact, as shown by chemical analysis, that it comes very close to oats in the carbohydrates and in the fat and protein. I am inclined to believe that in places where oats rust badly (this millet has never rusted) you may find it to be more profitable to grow as a grain crop than oats. In many localities men who keep dairy cows are troubled to know what to do for bedding. This straw makes splendid bedding. We are starting an experiment with meal made from this millet seed compared with ground oats as a food for the dairy cow. What the effect will be remains to be seen. Mr. J. J. H. Gregory, of whom most of you know, has said, in a letter to me, that he doubts whether there is any known crop, which will grow in a temperate climate, that is capable of producing so much food on a given area as this millet. I do not go quite so far as that.

QUESTION. Can we get the seed at the college?

Professor BROOKS. We shall have it this year, and shall be able to furnish it in somewhat larger quantities than heretofore. Heretofore we have never intended to let any one farmer have more than a peck. We will not be obliged to limit the amount this year.

QUESTION. Can we get the soy bean at the college?

Professor BROOKS. Yes; we can also furnish you with the soy bean. There are soy beans and soy beans. The green one is the best for the forage, so far as my observation goes. We have another very promising one, which I got through a missionary from China. We probably have half a bushel this year.

QUESTION. What is the use of shelling the corn? Do you not have crushers that take it cob and all?

Professor BROOKS. Yes; but you have to pay more for grinding, for the miller grinds it for you. It is more work to cut, bind, stack, husk and shell corn than it is to cut it and put it into the silo. I am thoroughly convinced that you cannot afford to try to make milk and butter without having a silo.

Dr. LINDSEY. I know there are a great many here who desire to say a word, and I do not want to take but just a moment. I want to say a word relative to what I call Professor Brooks's enthusiasm over millet. I believe in millet, but I cannot get up quite the amount of courage over it that he does. It seems to me, so far as I have been able to observe, that the Japanese millet, or so-called barn-yard millet, is of value chiefly as a green crop for the month of August, provided the weather is not sufficiently dry to prevent its growing. But I do not believe, from what I have been able to observe and from the data I have been able to obtain upon it, that it is superior to Indian corn. Our experience has been that, when we compare the Indian corn with the millet, our milk pail shows an increase in favor of the corn. Neither can I consider it of special value as a silage crop, in comparison with Indian corn. If we did not have Indian corn, millet would be desirable; but as long as we have the corn, I should very much prefer it as a silage crop. I do not agree with Professor Brooks in regard to the value of the seed, but I have no data from which to speak. It seems to me that the practical value of the millet at the present time is as a green crop, to be fed during the month of August. It is susceptible to dry weather. We planted one-fourth of an acre of it this year, and by its side had a fourth of an acre of corn. The corn withstood the drought

with no trouble, but we got very little millet. In regard to the soy bean, I have raised that quite extensively, although of course not in as large a way as they have on the college farm. Its great value is as a silage crop, to be used in connection with Indian corn; but the problem is, how to get it into the silo without costing too much money. If it costs too much to get it where the animal can consume it, of course its ultimate value is very much lessened. I have rather lost my courage in growing the soy bean, because we have to cut it with a scythe and have to use a fork to pitch it on to the wagon; and I find that my bill for filling my silo has been a good deal more than I wanted it to be when I used it in that way. This year we have grown it in connection with the corn as a trial in the same drill, and it has been so successful in a small way that I am going to try three or four acres next year. When I harvest the corn, it seems to me that I can harvest the bean at the same time, and in that way be economical.

QUESTION. Have we been going wrong in seeding with corn? Shall we put the ears of our corn into the silo?

Professor PHELPS. In regard to the first question, which was, whether you have been going wrong in seeding grass with the corn, I do not think it is altogether wrong. I should say it was all right, if it comes convenient with your planting. In regard to putting the ears into the silo, I think it is the most economical way of handling them. I do not think that we can afford to pick them off, husk them, shell them and grind them. I do not think we can afford to go to this expense for any gain that we might expect to get. I believe we get better returns by putting the stover and the ears into the silo all together, and feeding them together. This reminds me of the story of a Scotchman who went to a hotel. He was accustomed at home to having oatmeal for breakfast, and having cream on it, and he began to look about for some cream on this occasion. He found something that looked pretty blue, and he put some of that on his oatmeal. Later he found some cream, and put that on with the skimmed milk, and said, "There, go together where God made you and where you always ought to have been." I believe it is the same with the corn.

Professor BROOKS. I leave it for the audience to decide whether I said I thought the millet would take the place of the corn. I did not intend to say that. I never thought it would take the place of the corn.

Dr. LINDSEY. Don't you think the gentleman you spoke of made a mistake about having thirty-five tons to the acre?

Professor BROOKS. Yes; I said I thought so. I have no confidence in such calculations. As to growing soy beans along with the rows of corn or by itself, I am confident, although I have never had an exact experiment to which I can refer, that, if you plant two-thirds of a row to corn and one-third to the bean, you will get more food than if you planted the same row with the corn and the beans mixed, and I do not think the cost of handling it would be much greater. I know there is an idea that two or three kinds growing together will produce more on a given area than one kind, and that is sometimes so. Some recommend sowing two or three kinds of grain rather than one kind, and say you will get more. We all believe in sowing several kinds of grass, because they cover the ground. But the corn and the bean want the sunshine, and if you plant them together the bean soon gets into the shade. Dr. Lindsey has stated that he has had good results in growing them together. I believe that, as I do everything he says based on experiments, but in my opinion you will get more from a given area by planting the two separately.

Mr. C. B. LYMAN (of Southampton). I think if I put my corn all into ensilage it really does not amount to anything to harvest it. I may be mistaken. I know farmers in our town who handle ensilage have to pay ten to twelve dollars a day to run the silo filling.

Professor BROOKS. We put in about forty tons a day, and the cost of handling it is less than a dollar a ton. I have a copy of a very valuable book by Professor Henry of Wisconsin, who gives the results of a careful investigation set on foot by the Wisconsin Experiment Station, as to the cost of putting corn into the silo. It was shown that the average for the farmers all through the States of Wisconsin and Michigan was somewhere between sixty and sixty-seven cents per ton. That is less than we can handle

it. It depends a great deal on the number of tons per acre.

E. T. SABIN (of Amherst). There are a good many farmers here who have not a silo. I have a silo. I do not put my millet into the silo. I have raised millet for a number of years, and have never had a poor crop yet. I had one piece that was so heavy that when I came to mow it I said, "I guess I will see what I have," and I got off the machine and stood beside the millet, and it came up to my ears. If I had fertilized it a little more, I could have had it larger. You can sell millet for hay as well as you can sell herds-grass.

Secretary SESSIONS. One fact about red-top, which the speaker recommended: on a large tract of salt marsh in the town of Marshfield the only hay they can raise for the first few years is red-top, and that grows luxuriantly. This shows the tenacity of the red-top.

D. F. SHUMWAY (of Belchertown). You would advocate having a general farmer have a silo. What can we do with our hay crop? We cannot sell that to the bicyclists.

Professor PHELPS. Sell it to your neighbors. Keep more stock.

Mr. SHUMWAY. Then we shall be obliged to build barns to put our hay in.

Professor PHELPS. You can build barns to store hay very cheaply.

Mr. SHUMWAY. I have sold quantities of hay in Springfield and Holyoke, but I have sold but one load this fall. The market is full of hay. If we put up silos, we will have to build barns every year.

Professor PHELPS. These conditions are not going to exist right along. The chances are that we will go to the other extreme in the production of hay within five years.

Mr. SHUMWAY. Horses are slowly going out of use, and the things we have to feed hay to are growing less.

Professor PHELPS. I told you in my paper that the people in the cities are using as much hay as ever, notwithstanding the use of the trolley cars and the bicycles.

Mr. EDMUND HERSEY (of Hingham). Before this meeting adjourns I want to express my personal obligation to

the people of Amherst and to the president and professors at the college and experiment station for the cordial reception we have received and for the interest shown in these meetings. I have no doubt all the members of the Board of Agriculture have the same feelings; and I now move that the thanks of the Board of Agriculture be extended to the town of Amherst for the free use of this hall, to the president and professors at the Massachusetts Agricultural College and Hatch Experiment Station for their kind assistance in carrying on the meetings, and to the people of the village for the cordial reception we have received.

The motion was unanimously carried.

Adjourned at 4.05 P.M.

DESCRIPTION OF EXHIBIT MADE BY THE HATCH
EXPERIMENT STATION AT THE WINTER MEET-
ING OF THE STATE BOARD OF AGRICULTURE,
AMHERST, DEC. 6-8, 1898.

BY DR. J. B. LINDSEY, AMHERST.

A. AGRICULTURAL DEPARTMENT.

This department exhibited a considerable variety of fodder stuffs and vegetables, grown for the purpose of studying varieties, and to observe the effects of different methods of fertilization on growth and development.

1. *Fertilizer Tests for Ten Years with Corn.* — This exhibit illustrated the yield from one-twentieth of an acre, when no fertilizer was used, when a one-sided fertilizer such as phosphoric acid or phosphoric acid and potash was applied, when a complete fertilizer containing nitrogen, phosphoric acid and potash was employed, and when barn-yard manure served as the exclusive source of plant food. The entire amount of corn from each of the one-twentieth acre plots was placed in barrels, thus illustrating quite forcibly to the observer the noticeable differences in yield resulting from the different fertilizers applied. The yields were as follows: no fertilizer, 10.5 bushels of ears per acre; phosphoric acid alone, 18.5 bushels per acre; phosphoric acid and potash, 41.2 bushels per acre; nitrogen, phosphoric acid and potash, 55.9 bushels per acre; and barn-yard manure, 67.7 bushels per acre. The amount of fertility in the barn-yard manure was considerably greater than that applied in the form of the complete fertilizer, and the manure plot naturally showed a somewhat larger yield. The effects of plant food applied either in the form of fertilizers or as barn-yard manure is strikingly shown when it is observed that where no fertilizer was applied the yield

was 10.5 bushels per acre; with phosphoric acid alone, 18.5 bushels; and with a complete fertilizer or barn-yard manure, 56 to 67 bushels, per acre.

Two standard varieties of corn (stalk and ear), the Pride of the North and Denhen, were shown. The former is considered preferable for Massachusetts. Two new varieties, the Klondike and Prehistoric, were exhibited. They showed no practical utility for this section. Some twenty-five of the most desirable varieties of corn (stalks and ears) were neatly arranged side by side, in order to enable the observer to see at a glance their general appearance and character.

2. *Potatoes*.—Eighty new varieties of potatoes were shown, all grown as nearly as possible under similar conditions. Those producing 250 bushels or over per acre were Burr's No. 1, Champion of the World, Ford's No. 31, Early Minnesota and Garfield.

Variety tests with potatoes are very uncertain, depending upon weather conditions, size of plots used for tests, acclimatizing of varieties, etc. So far as tests of this character are concerned, taking the average results for several years, it has been shown that the newer varieties show no improvement in yield over such standard sorts as Early Maine, Early Rose and Beauty of Hebron.

3. *Fodder Plants*.—Sixteen varieties of millet, both plants and seed, were placed in such a way as to give the observer an excellent opportunity to note the appearance of each distinct kind. The so-called barn-yard millet, a Japanese variety, and the golden millet, proved to be most desirable for fodder purposes.

Among the leguminous forage crops exhibited and deserving mention were four varieties of plants and seeds of the soy bean, as well as the cow pea and horse bean. The medium green soy bean has proved to be decidedly superior to the others.

Three varieties of sorghum, plants and seeds, illustrated the character of this plant. It has no great practical value for our locality.

4. *Sweet Clover for Green Manuring*.—The mature plants and seeds of sweet clover attracted attention. This

plant will probably prove quite valuable for green manuring. It produces a rank growth of foliage, grows rapidly, and can be turned under the latter part of June.

Nitragin is a germ fertilizer used to inoculate the roots of leguminous plants to induce them to utilize atmospheric nitrogen. It was used upon sweet clover grown upon light land, and the clover plants as grown with and without its aid were shown. The plants receiving nitragin showed an improvement over those where no nitragin was applied, but were not nearly as luxuriant as those receiving fertilizer nitrogen. It is possible that, if this crop was grown upon the same land for several years with the aid of nitragin, a considerable improvement would be noticed in the growth of the clover. Nitragin has not thus far shown itself to be of any great value upon our soils.

Besides the sweet clover, there were shown the blue, white and yellow lupine and the velvet bean, which have been recommended for green manuring. The most desirable variety of lupine to be used is the white. The velvet (Florida) bean does not seem to be of any great advantage for use in this section.

5. Poultry experiments are carried on by the agricultural department. The experiment this season is an attempt to demonstrate the comparative values of wide *v.* narrow rations. Two pullets were shown, and the feed was placed before each, showing what each pullet—representing a flock—was receiving for its daily supply. In one case corn represented the chief food, and in the other a mixture of wheat bran middlings and gluten meal. It is assumed, and very properly, that laying hens producing eggs rich in nitrogenous matter need considerable quantities of such material in the food, in order to enable them to produce a maximum egg yield.

6. *Pot Experiments.*—The department is carrying on a large number of experiments in pots, to control the results obtained in the field, and to endeavor, by being able to better control the conditions, to secure more uniform results than field experiments often give. The pots employed for this work were shown, as well as many of the results obtained.

7. Among the vegetables placed on exhibit by the department were very attractive groups of Giant Pascal celery, White Egg turnip and Brunswick cabbage.

B. HORTICULTURAL DEPARTMENT.

1. This department made a very excellent and attractive display of thirty-eight varieties of apples. They were placed five in a plate, upon a table running lengthwise of the hall. These varieties were: Jacob's Sweet, Mother, Swaar, Beauty of Kent, Leicester Sweet, Hubbardston Nonesuch, Porter, Haas, Carlough, General Lyon, Fall Pippin, Westfield Seek-No-Further, Palmer Greening, Lord's Apple, Wagener, Hurlbut, Baldwin, Indian Scion, Tolman Sweet, Gano, Winesap, Lady Apple, Pound Sweet, Ben Davis, King of Tomkins County, Roxbury Russet, Sutton Beauty, Arabskoe, Brilliant, Scarlet Cranberry, Shiawassee Beauty, Lady Sweet, Walbridge, Gilliflower, Rhode Island Greening, Pewaukee, Fanny and Danvers Sweet.

2. The four varieties of grapes shown were: Herbert (Rogers No. 44), Iona, Oneida and Wilder (Rogers No. 4).

3. Quite a large display of nursery stock was made, mounted on frames, enabling one to see at a glance the objects to be illustrated. In the case of the cherry, plum, apple and peach, the various stages, from the stock to the tree ready to set out, were strikingly shown.

In case of the peach, the following stages were illustrated: (1) seed as planted about May 10; (2) shoot budded in September of same year; (3) stock with live bud; (4) stock cut off just above live bud, allowing only the latter to grow; (5) one-year-old tree; (6) various methods of pruning the peach tree.

The apple was illustrated in much the same way, showing stock with live bud, the one, two and three year old tree, and a two-year-old tree, one year transplanted. Following the apple was the cherry, showing the live buds in both the Mazzard and Mahaleb stock, one and two years old, as well as the two-year-old stock, one year transplanted. The plum closed the series, with live buds, in both the Mariana and Myriobolan stocks, one and two year old trees, as well as a two-year-old tree, one year transplanted. Currant and grape

propagation was shown from cuttings, and also from cuttings that had rooted, and made one and two years' growth. In all cases the entire root system so far as possible was taken up with the stocks.

Several new stocks, to be used in budding the pear and apple, were exhibited, among which was the *Pyrus betulæ-folia*, a new pear stock of great promise, it not being affected by blight.

C. DEPARTMENT OF FOODS AND FEEDING.

This department showed thirty-five samples of the most prominent concentrated feed stuffs in large glass jars. The feeds were arranged with reference to the amount of protein they contained, the label on each jar stating the protein percentage. The feed stuffs are chiefly the by-products from the cotton and linseed mills, the glucose factories, flour mills, distilleries, and factories employed in the preparation of various breakfast foods.

D. THE COLLEGE FARM.

The college farm made quite an attractive display of vegetables and fodder plants (grown quite extensively upon the farm) in a small room in the rear of the hall. Those deserving of special mention were turnips, carrots, mangolds, celery, potatoes, beans, soy beans and millet.

E. DAIRY MACHINERY, ETC.

In a room in the lower hall the Moseley & Stoddard Manufacturing Company exhibited a very complete line of their DeLaval separators and other dairy machinery; and the Worcester Salt Company displayed samples of its pure salt for dairy use.

ANNUAL MEETING
OF THE
BOARD OF AGRICULTURE,
AT
BOSTON.

JANUARY 10 AND 11, 1899.

ANNUAL MEETING.

In accordance with the provisions of chapter IV. of the by-laws, the Board met at the office of the secretary, in Boston, on Tuesday, Jan. 10, 1899, at 11 o'clock A.M., it being the Tuesday preceding the second Wednesday of January. In the absence of the president, Governor WOLCOTT, the Board was called to order by the first vice-president, Hon. James S. Grinnell.

Present: Messrs. F. H. Appleton, J. S. Appleton, Baker, Barton, Benedict, Bowditch, Bursley, Clark, Damon, Davis, Ellsworth, Goodell, Goodspeed, Grinnell, Hall, Hersey, Kilbourn, Lloyd, Pratt, Reed, Richardson, Sargent, Sessions, Shaw, F. H. Smith, Geo. P. Smith, Stockwell, Thayer, Whitmore and E. W. Wood.

The records of the public winter meeting and of the special meeting of the Board at Amherst were read and approved.

The executive committee, by Mr. E. W. Wood, chairman, reported the list of qualified members of the Board for 1899. The newly elected members are as follows:—

At large, appointed by the Governor:—

JAMES S. GRINNELL of Greenfield.

Elected by the societies:—

Bristol County, EDWARD M. THURSTON of Swansea.

Deerfield Valley, HENRY A. HOWARD of Colrain.

Essex, FRANCIS H. APPLETON of Peabody.

Highland, C. K. BREWSTER of Worthington.

Hillside, ALVAN BARRUS of Goshen.

Middlesex South, ISAAC DAMON of Wayland.

Plymouth County, AUGUSTUS PRATT of North Middleborough.

Worcester, J. LEWIS ELLSWORTH of Worcester.

Worcester County West, CHARLES A. GLEASON of New Braintree.

The report of the committee was accepted and adopted.

An abstract of the annual report of the secretary was presented, read and accepted.

The records of the executive committee, acting for the Board, were read by the secretary and approved, and the acts of the committee were adopted as the actions of the Board.

The report of the Dairy Bureau was read by the assistant to the executive officer of the Bureau, Mr. Geo. M. Whitaker, and was accepted by vote of the Board.

The committee on agricultural societies, by Mr. Kilbourn, chairman, presented a written report, which was accepted and adopted.

The committee on domestic animals and sanitation, by Mr. Damon, chairman, presented a written report, which was accepted and adopted.

The report of the committee on gypsy moth, insects and birds was presented at the special meeting of the Board at Amherst, Dec. 8, 1898, and was accepted and adopted at that time.

The report of the committee on Agricultural College and education was read by the secretary of the committee, Mr. J. W. Stockwell, and by vote of the Board was accepted and adopted as the report of the Board to the Legislature.

The committee on experiments and station work, by Mr. Edmund Hersey, chairman, presented a written report, which was accepted and adopted.

The committee on forestry, roads and roadside improvements, by Gen. F. H. Appleton, chairman, presented a report, which was accepted and adopted.

The reports of the several committees will be found printed in this volume.

The hearing on the request of the Worcester Agricultural Society for the approval of its vote at the annual meeting duly called for the purpose, that "the president, two vice-presidents, member of the State Board of Agriculture, the secretary and treasurer, be authorized to borrow a sum not exceeding \$5,900 to pay the bills of the society, and that they be empowered to give a good and sufficient mortgage on the real estate of the society for the same." The delegate of the society, J. L. Ellsworth, presented a copy of the records of the society's actions, duly certified and sworn to by the secretary. There was also presented by him copies of the newspapers containing the advertisement of the call for the said annual meeting, and also copies of the newspapers containing the advertisement of the hearing of the matter by the Board of Agriculture. The delegate of the society gave an account of the conditions that made it necessary for the society to give an increased mortgage of its property, and answered questions on the matter by members of the Board. It appearing that the action of the society was according to law and properly advertised, and by a two-thirds vote of members of the society present and voting, and no person appearing in opposition to the request of the society, it was

Voted, That the Board of Agriculture approves of the vote of the Worcester Agricultural Society, passed at the annual meeting of said society, Nov. 29, 1898, as above quoted.

Voted, That the secretary of the Board be instructed to notify the society of the action of the Board.

The report of the librarian was read by the secretary, and a complete catalogue of the library of the Board was presented.

Voted, To accept the report and the catalogue.

Voted, to reconsider the vote passed at the last annual meeting, "That the catalogue of the library be published in the 'Agriculture of Massachusetts' which is published next after the completion of the catalogue."

Voted, That the catalogue prepared by the librarian be printed separately, in such form as shall be decided by the secretary and the chairman of the executive committee, at an expense not to exceed \$200, the same to be paid from the appropriation for incidentals or for dissemination of useful information in agriculture.

An abstract of the reports of inspectors of the several fairs, prepared by direction of the committee on agricultural societies, was read by the secretary, who stated that the reports of the inspectors, by direction of the committee on agricultural societies, had been transmitted to the several societies interested.

Voted, To accept the reports of inspectors.

Voted, That, when the Board adjourns, it be to meet on Wednesday, January 11, at 10 o'clock A. M., and that the ballot for officers begin at 11 o'clock.

Adjourned.

SECOND DAY.

The Board met at 10 A.M., Second Vice-President Wood in the chair.

Present: Messrs. Allen, F. H. Appleton, J. S. Appleton, Baker, Barrus, Barton, Benedict, Bowditch, Brewster, Bursley, Clark, Damon, Davis, Ellsworth, Gleason, Goodell, Goodspeed, Hall, Hersey, Howard, Kilbourn, Lloyd, Pratt, Reed, Richardson, Sargent, Sessions, Smith, Stockwell, Taft, Thayer, Thurston, Whitmore and E. W. Wood.

The records of the first day were read and approved.

Voted, That the pamphlet of laws relating to the Board of Agriculture and the agricultural societies, with the by-laws and regulations of the Board, be reprinted.

Voted, That a committee of five be appointed by the Chair, three to be members of the Board and two to be prominent citizens of the State, to act as a committee of arrangements for the meeting of the Farmers' National Congress, which is to be held on invitation of the Board of Agriculture in Boston next autumn. The Chair appointed F. H. Appleton, J. W. Stockwell, W. A. Kilbourn, John G. Avery of Spencer and R. G. F. Candage of Brookline.

At this point First Vice-President GRINNELL came in and assumed the chair.

Mr. C. K. BREWSTER read an essay on "The Massachusetts Agricultural College: its criticisms; its benefits," which was accepted, and will be found printed in this volume.

Voted, That the two members over the number necessary to fill the committees be assigned one to the committee on domestic animals and sanitation and one to the committee on Agricultural College and education.

The chairman appointed the standing committees, as follows (the secretary is by rule of the Board a member *ex officio* of each of the standing committees) :—

Executive committee: Messrs. E. W. Wood of West Newton, W. A. Kilbourn of South Lancaster, Isaac Damon of Wayland, D. A. Horton of Northampton, John Bursley of West Barnstable, Edmund Hersey of Hingham and Francis H. Appleton of Peabody.

Committee on agricultural societies: Messrs. W. A. Kilbourn of South Lancaster, Q. L. Reed of South Weymouth, O. P. Allen of Palmer, N. B. Baker of Savoy and Chas. A. Gleason of New Braintree.

Committee on domestic animals and sanitation: Messrs. Isaac Damon of Wayland, Oscar S. Thayer of Attleborough, Joshua Clark of Tewksbury, F. L. Whitmore of Sunderland, Almon W. Lloyd of Blandford and Henry A. Howard of Colrain.

Committee on gypsy moth, insects and birds: Messrs. E. W. Wood of West Newton, Augustus Pratt of North Middleborough, F. W. Sargent of Amesbury, S. S. Stetson of Lakeville and N. I. Bowditch of Framingham.

Committee on Dairy Bureau and agricultural products: Messrs. D. A. Horton of Northampton, J. L. Ellsworth of Worcester, C. D. Richardson of West Brookfield, C. B. Benedict of Egremont and E. E. Wood of Northampton.

Committee on Agricultural College and education: Messrs. John Bursley of West Barnstable, C. K. Brewster of Worthington, Wesley B. Barton of Dalton, J. W. Stockwell of Sutton, Geo. P. Smith of Sunderland and Alvan Barrus of Goshen.

Committee on experiments and station work: Messrs. Edmund Hersey of Hingham, Walton Hall of Marshfield, J. S. Grinnell of Greenfield, T. H. Goodspeed of Athol and J. Elton Green of Spencer.

Committee on forestry, roads and roadside improvements: Messrs. Francis H. Appleton of Peabody, J. S. Appleton of Nantucket, E. A. Davis of West Tisbury, Samuel B. Taft of Uxbridge and E. M. Thurston of Swansea.

Which appointments were approved by the Board.

Election of officers being in order, the chairman declared His Excellency ROGER WOLCOTT president of the Board (by a by-law of the Board the Governor of the Commonwealth is *ex officio* president).

By an election by ballot Hon. JAMES S. GRINNELL of Greenfield was elected first vice-president and E. W. WOOD of West Newton second vice-president.

At this point Secretary Sessions, in accordance with notice given at the last annual meeting, presented his resignation of the office of secretary, to take effect at the end of the present month; and also reiterated the statement made at said annual meeting, that he would not accept of another election.

On motion of E. W. Wood, chairman of the executive committee, it was

Resolved, unanimously, that the Board requests the secretary to withdraw his resignation, and serve the remainder of the year to which he was elected, viz., until July 1.

The secretary acceded to the request of the Board, and consented to serve out the year.

Balloting for secretary being in order, several ballots were taken, and the final ballot resulted in the election of Hon. JAMES W. STOCKWELL of Sutton.

On motion of President Goodell, the election was made unanimous.

Election of specialists being in order, ballots were taken, and the election resulted as follows:—

Chemist, Dr. C. A. GOESSMANN of Amherst.

Entomologist, Prof. C. H. FERNALD of Amherst.

Botanist and pomologist, Prof. S. T. MAYNARD of Amherst.

Veterinarian, Prof. JAMES B. PAIGE of Amherst.

Engineer, WILLIAM WHEELER of Concord.

Ornithologist, E. H. FORBUSH of Malden.

Adjourned to 1.30 P.M.

The Board was called to order at 2 P.M., Mr. GRINNELL in the chair.

Mr. N. I. BOWDITCH read an essay on “The Board of Agriculture,” which was accepted, and will be found printed in this volume.

The committee on Agricultural College and education, by Mr. Bursley, chairman, reported recommending that the next public winter meeting be held at Westfield, on invitation of the Union Agricultural and Horticultural Society and the citizens of Westfield.

Voted, To accept the report, and that the next public winter meeting be held at Westfield, Dec. 5-7, 1899.

Voted, That the Chair appoint a local committee of five, to act with the secretary and the committee on Agricultural College and education as a committee of arrangements. The Chair appointed Messrs. A. W. Lloyd, O. P. Allen, C. K. Brewster, D. A. Horton and W. B. Barton.

The matter of representation of Massachusetts agriculture at the Paris Exposition of 1900 being in order, on motion of General Appleton, it was

Voted, That the Board heartily approves of the movement to secure as ample an exhibition of the agriculture of Massachusetts at the Paris Exposition of 1900 as shall be found possible, and recognizes the Agricultural College and Experiment Station faculties as those bodies best fitted to arrange such an exhibit in behalf of this State.

The secretary reported the delinquencies of certain societies in making required returns.

Voted, That the matter of delinquencies be referred to the executive committee, with power to excuse the societies if they present reasonable excuses.

Voted, That the executive committee be instructed to appear for the Board before committees of the Legislature when matters of interest to this Board are being heard, and that it be empowered to invite such other persons as it may think proper to assist at such hearings.

The committee on agricultural societies, by Mr. Kilbourn, chairman, reported recommending that the date for the commencement of the fair of the Blackstone Valley Agricultural Society be changed to the second Tuesday after the first Monday in September, that of the Franklin County Agri-

cultural Society to the third Wednesday after the first Monday in September, that of the Hampshire Agricultural Society to the fourth Tuesday after the first Monday in September, that of the Manufacturers' Agricultural Society to the second Wednesday after the first Monday in September, and that of the Marshfield Agricultural and Horticultural Society to the Wednesday preceding the first Monday in September.

Voted, To accept and adopt the report of the committee, and to change the dates as recommended.

Mr. Kilbourn, for the same committee, reported recommending the assignment of inspectors, as follows:—

Amesbury and Salisbury, at Amesbury, September 26, 27 and 28, ...	C. K. BREWSTER.
Barnstable County, at Barnstable, August 29, 30 and 31, ...	H. A. HOWARD.
Berkshire, at Pittsfield, September 12, 13 and 14, ...	Q. L. REED.
Blackstone Valley, at Uxbridge, September 12 and 13, ...	F. H. APPLETON.
Bristol County, at Taunton, September 19, 20 and 21, ...	F. W. SARGENT.
Deerfield Valley, at Charlemont, September 14 and 15, ...	J. L. ELLSWORTH.
Eastern Hampden, at Palmer, September 19 and 20, ...	W. A. KILBOURN.
Essex, at Peabody, September 19, 20 and 21, ...	J. S. APPLETON.
Franklin County, at Greenfield, September 20 and 21, ...	A. W. LLOYD.
Hampshire, at Amherst, September 26 and 27, ...	C. A. GLEASON.
Hampshire, Franklin and Hampden, at Northampton, October 4 and 5, ...	ISAAC DAMON.
Highland, at Middlefield, September 6 and 7, ...	C. D. RICHARDSON.
Hillside, at Cummington, September 26 and 27, ...	JOSHUA CLARK.
Hingham, at Hingham, September 26 and 27, ...	T. H. GOODSPEED.
Hoosac Valley, at North Adams, September 20, 21 and 22, ...	C. B. BENEDICT.
Housatonic, at Great Barrington, September 27 and 28, ...	O. P. ALLEN.
Manufacturers' Agricultural, at North Attleborough, September 13, 14 and 15, ...	EDMUND HERSEY.
Marshfield, at Marshfield, August 30 and 31 and September 1, ...	E. A. DAVIS.
Martha's Vineyard, at West Tisbury, September 19 and 20, ...	ALVAN BARRUS.

Massachusetts Horticultural, at Boston, October 3 and 4, ...	N. I. BOWDITCH.
Middlesex North, at Lowell, September 14, 15 and 16, ...	J. E. GREEN.
Middlesex South, at Framingham, September 12 and 13, ...	E. E. WOOD.
Nantucket, at Nantucket, August 30 and 31, . . .	N. B. BAKER.
Oxford, at Oxford, September 7 and 8, ...	S. B. TAFT.
Plymouth County, at Bridgewater, September 13, 14 and 15, ...	WALTON HALL.
Spencer, at Spencer, September 21 and 22, . . .	GEO. P. SMITH.
Union, at Blandford, September 13, 14 and 15, .	O. S. THAYER.
Weymouth, at South Weymouth, September 28, 29 and 30, ...	F. L. WHITMORE.
Worcester, at Worcester, September 5, 6 and 7, .	E. M. THURSTON.
Worcester East, at Clinton, September 14 and 15, .	AUGUSTUS PRATT.
Worcester North-west, at Athol, September 13 and 14, ...	E. W. WOOD.
Worcester South, at Sturbridge, September 14 and 15, ...	W. B. BARTON.
Worcester County West, at Barre, September 28 and 29, ...	JOHN BURSLEY.

The report of the committee was accepted and adopted.

The committee on Agricultural College and education, by Mr. Bursley, chairman, reported recommending the appointment of Geo. P. Smith and O. P. Allen to read essays at the next annual meeting of the Board, on subjects to be selected by the essayists.

Voted, To accept the report, and appoint the essayists as recommended by the committee. Later, Mr. Smith announced his subject as "Evolution of farm machinery," and Mr. Allen as "The evolution of agriculture."

Voted, That a special committee of five be appointed by the Chair to report to the next annual meeting recommendations for such changes and improvements in the system of holding farmers' institutes as may be considered desirable. The Chair appointed Messrs. Hersey, Gleason, Sargent, Richardson and Stockwell.

Voted, To amend Rule 16 of the Board, by striking out, in the sixth and seventh lines of said rule, the words "also

attend these institutes, so far as is compatible with the duties of his office; and he shall," so that the rule shall read as follows:—

RULE 16. Each agricultural society receiving the bounty of the Commonwealth shall hold within its limits not less than three farmers' institutes each calendar year; and the Board shall render all the assistance in its power to make such institutes interesting and profitable. The secretary of the Board shall provide lectures for the institutes, so far as the appropriation for this object will warrant, but he shall not be authorized to pay more than one lecturer for each institute. Each society may hold more than three institutes, if it so desires; and the secretary of each society shall be required to certify to the holding of each institute, on blanks furnished by the secretary of the Board.

Voted, That the Board of Agriculture cordially endorses the application of the trustees of the Massachusetts Agricultural College to the Legislature for an additional annual maintenance fund of ten thousand dollars.

Voted, That the thanks of the Board be tendered Messrs. JOHN G. AVERY and R. G. F. CANDAGE for their successful efforts in procuring the next session of the Farmers' National Congress to be held in Boston.

Voted, That the thanks of the Board be tendered to Vice-President GRINNELL for the able and genial manner in which he has performed the duties of presiding officer.

President H. H. GOODELL was recognized by the presiding officer. He said: Mr. Chairman, it seems eminently fitting that we should recognize at this time the services of our honored secretary, who has for eleven years labored in your service faithfully, honestly and diligently, and who has administered your affairs in the most impartial and judicious manner possible. We part from him with regret, and wish him all prosperity in the future of his life. I move, sir, that by a rising vote we express our appreciation

of what he has done for this Board and for the agricultural interests of this Commonwealth.

The question was put, and every member rose.

The records of the second day's meeting were read and approved.

Adjourned.

WILLIAM R. SESSIONS,

Secretary.

REPORT TO THE LEGISLATURE OF THE STATE
BOARD OF AGRICULTURE, ACTING AS OVER-
SEERS OF THE MASSACHUSETTS AGRICULT-
URAL COLLEGE.

[P. S., Chap. 20, Sect. 5, adopted by the Board, Jan. 10, 1899.]

To the State Board of Agriculture, Overseers of the Massachusetts Agricultural College.

Your committee has attended to the duties assigned, and its members have visited the college frequently to note methods and results, attending the commencement exercises and awarding the Grinnell agricultural prizes. At the first meeting the committee organized with John Bursley, chairman, *ex officio*, and J. W. Stockwell, secretary. Work was assigned to each member of the committee on special lines, and the observations and deductions were approved in committee of the whole.

THE GRINNELL PRIZES.

The Grinnell prizes were awarded as follows: first, to Clifford Gay Clark, Sunderland; second, to George Henry Wright, Deerfield; honorable mention, Avedis Garrabet Adjemian, Kharpoot, Turkey.

Your committee was sorry to find so small a class contesting for these prizes (only three), but the essays were so well written, the elocution so correct, and the class room examination showed such a thorough understanding of the subjects considered, that three first prizes would have been a most welcome solution of the problem. As it is, we highly commend each of the contestants for excellence in the hall and in the examinations.

THE FARM.

On the farm the operations of the year have been simply routine in their nature. No extended improvements have been made. An underdrain about 1,200 feet in length has been put in on one of the fields; other drains have been kept in good order. Some new fence has been built. The grounds are neat and tasteful, and the buildings well cared for and cleanly. The crops on the farm were excellent, grass, millet and soya beans being especially productive. Only one suggestion: The stock on the farm was bought for a purpose, or to demonstrate a theory, an experiment; that purpose is accomplished. To now dispose of the stock that is not profitable and replace it with some of the finest animals of the best breeds, would, we believe, be more in accord with the demands of the college, more profitable and more instructive. In judging the farm results, we must remember that it is not carried on to demonstrate the profits of farming, but as a part of the school work; and every year much of success must be sacrificed to the educational features of the college.

THE EXPERIMENT STATION.

This department confines itself largely to the study of questions connected with the composition of manures and other fertilizers. It is endeavoring to find out how to feed plants most economically. It carries out a large amount of plot work upon the station grounds and a limited amount upon land belonging to selected farmers in different parts of the State. Variety tests of ordinary farm crops claim attention, a large amount of work being done yearly in this line. Cultural experiments are also undertaken. Trials of implements and machines are made. Poultry experiments also come under this department, and interesting comparisons have been made in feeds and feeding for egg-production. It seems on many accounts desirable that the scope of this work in connection with poultry be extended. The poultry interests of the State are very large, and rapidly increasing. Light is needed upon many problems of feed, care

and most profitable returns, These experiments would be a source of profit to the institution.

In the other lines enumerated above the work of the previous years has been continued, and in addition two entirely new lines of experimental enquiry have been instituted.

First. — Experiments in tiles, two feet in diameter and four feet deep, set upright in the ground and filled with equal quantities of thoroughly mixed earth. The object in view is the determination of certain questions as to the use of manures or fertilizers under conditions which guarantee and secure accurate results. Two soil tests; one comparative trial of seven different phosphates; one experiment in liming and one test to determine the extent to which the product of individuals under similar conditions will vary. The results of the fertilizer trials are of course not decisive in a single year. The test for the purpose of bringing out the individuality of different tubers of the same variety of potatoes of the same size and form emphasizes the necessity of caution in attaching too much importance to results obtained in variety trials upon a small scale.

Second. — Pot experiments. The use of zinc pots about ten inches in diameter and about twelve inches deep for experiments pertaining to the feeding of plants has been begun. The success in growing oats, corn, potatoes and beans in these pots was gratifying. All grew in an entirely normal and healthy manner. By this system conditions were perfectly controlled, and many sources of inaccuracy and error, unavoidable in the field work, eliminated. This line of experiment will be largely extended another year.

We can only mention other experiment work and deductions, — a full statement would take too much time.

In feeding for eggs, the comparison with cut bone and animal meal has been continued, with results decisively in favor of animal meal. The use of Sheridan's condition powders for laying hens has been further tested, with results against the use of the powders. Two rations for hens, one containing a large quantity of wheat, the other substituting corn, have been tried, with results decisively in favor of the

corn, the hens on this feed having given more eggs at a less cost and gained more in weight than the others.

The extent to which any variety of potatoes may be influenced by the place in which the seed was raised has been tested. The difference in the yield under precisely similar conditions was large.

In the fertilizer experiment, the most striking points brought out were: first, the injurious effects of muriate of potash in depleting the soil of lime; second, that sulphate of potash has much less effect in this direction, and is therefore a safer fertilizer to use unless the soil is naturally rich in lime.

The usual fertilizer experiments have been made, and the department of foods and feeding has conducted a series of valuable experiments, to ascertain the value of the various prepared cattle foods now upon the market that are by-products from the cereal manufactories.

EXPERIMENT WORK. HORTICULTURAL DEPARTMENT.

We shall again refer to this department. We here speak only of experiment work and results.

First. — Testing varieties of fruits, vegetables, ornamental trees, shrubs and flowers. Only such as are recommended as having decided merit are given trial. As varied a range of soil and exposure as possible is given each kind, and its behavior in other localities is also studied. The results are very carefully and accurately determined.

Second. — Fertilizer experiments are carried on with many kinds of fruits, *i. e.*, the effect of special fertilizers in improving the vigor of peach trees, and the best fertilizers for fruit trees growing in grass land are the more important.

Third. — Testing new fruit stocks. Several new stocks for the pear are being tried; also the effect of the peach and plum stock in growing the Japanese and native varieties.

Fourth. — Spraying crops for profit. Studying the best methods; the best pumps, the best and cheapest insecticides and fungicides, and the time when best applied.

The principal difficulty in this work is the lack of sufficient time in which to give the student sufficient knowledge and skill to fit him to practise successfully any line of horti-

culture he may desire to follow after graduating. Yet the number of graduates from this department who have taken up lines of horticultural work with remarkable success is large, and they have come almost entirely from those who have been obliged to work to earn funds to pay their college expenses.

CLASS-ROOM WORK.

The Massachusetts Agricultural College aims to teach scientific and experimental knowledge in its relation to agriculture and also to other industries and professions. Instruction is given largely by lectures and practical demonstrations in the laboratory, supplemented by text-books and library references, for which purpose a library, now containing 18,497 volumes, has been provided for use of students. Technical training is given in those operations in agriculture and horticulture that require skilled labor, and are best taught by experiment work; *i. e.*, care and feeding of stock, dairying in all its departments, budding, grafting and pruning of trees and vines, spraying, transplanting, etc.

Students in the senior year are allowed to select those studies (three each term) that are calculated to fit them for the line of work they intend to pursue. This plan has not been in operation long enough to determine its results to the college or to the students.

COURSE OF STUDY.

Agriculture.

The lecture room is well equipped with numerous charts and lantern slides to illustrate the subjects taught. There is also a large collection of different soils, fertilizing materials, concentrated foods, grasses, grains and forage plants. There is a series of Landberg's models of the leading breeds of farm animals. Students are required to take notes, and are later examined on the various subjects, — soils, their formation and origin; methods of testing soils to determine their fertility; manures and fertilizers; animal husbandry; breeding, management and feeding of stock; conditions for successful culture of all farm crops, — are some of the subjects treated.

Horticulture.

This department is provided with a large orchard, vineyard, greenhouse, nursery and garden, for practical illustration and study of horticulture, floriculture and market gardening. This practical work in the greenhouse and the field is a present test of class-room knowledge and skilled hand in working out nature's problems. "To him who in the love of nature holds communion with her various forms" it is a delight to visit this part of the college grounds. The greenhouses, the rose garden, the artistic arrangement of the grounds, perfect shrubbery, kept free from parasites, the fruits growing under best conditions, are a lesson and an inspiration.

Botany.

In the botanical department a systematic and thorough education is gained by means of lectures and laboratory work. Particular attention is given to plants grown for economic purposes, structure and function of different parts of the plant, diseases of plants, and the effect of electricity on plant growth.

Zoölogy.

The work in this department includes the subjects, — physiology, zoölogy and entomology. These are taught by text-books, lectures and laboratory work, illustrated by charts, models, and a museum containing 4,250 distinct species, comprising 12,000 named specimens. This museum is one of the most complete found at any college in the country. In the laboratory, lower forms of life are studied under the microscope. An advanced course in entomology is given to those who so elect in the senior year.

Chemistry.

Fourteen rooms are used in this department as lecture rooms and laboratories. The knowledge of elements and principles studied in the lecture room are applied in the laboratory. Salts, minerals, soils and fertilizers are analyzed. The laboratories are well supplied with apparatus of the

most modern and improved kind, to furnish the student with a complete and thorough course in this very important branch of learning.

Veterinary.

The new buildings now in process of erection will greatly improve and facilitate the work of the professor in this science, and cannot fail to prove of great value to veterinarians, students and farmers. In the new laboratory and barn, students will become acquainted with sick animals, taught to diagnose disease and prescribe remedies. Here dangerous and contagious diseases can be studied and treated, and problems solved for the benefit of the State.

It is proposed to have the farmers feel at liberty to send material for examination, and, in case of the appearance of obscure or peculiar disease, here to carry on investigations with reference to them.

We will not report at length in regard to other branches of learning which are common to all colleges, or of the short winter courses of study. This class-room report shows that the Massachusetts Agricultural College is thoroughly equipped to accomplish the work as stated in the act of Congress which provided for its endowment.

This college is not narrowed in any other line of science, language or classic lore. Its opportunities for furnishing a liberal and thorough education are equal to the other colleges of the State. Its professors are teachers of acknowledged excellence. It is simply broadened by experiment work and practical knowledge in agricultural art. Its four hundred acres are for the benefit of the students in agricultural instruction; yet they are an open book to every student, in whatever course, and must inspire a love of nature that shall redound in blessing in after life. We bring more distinctly before you and the State the agricultural department, because we have watched its progress and noted its results in the year past, and because it is the distinctive line that most directly appeals to the Massachusetts Board of Agriculture.

The one lack of this college is students. This we must admit. The farmers of the State are not as prosperous as in

past years. The sons cannot be spared from the farm or the money furnished for a college course without sacrifice. We hope for the good time coming, that it is almost here. When it comes there will be no lack of students at our college. It is not the fault of our care; it is not the fault of the college; it is largely the result of conditions which we hope are passing away.

That the Board of Agriculture may come into closer relations to the college and become more useful to it by bringing to young men a knowledge of the opportunity here offered for an education, we would suggest that the law relating to free scholarships be so modified or amended that it may become the duty and privilege of each member of the Board to appoint at least one candidate for admission to the college each year.

Chapter 20 of the Public Statutes defines and constitutes the Massachusetts State Board of Agriculture. Section 3 declares that "the Board shall meet at the State House or at the Agricultural College at least once in each year," and section 5 says "The Board shall be a Board of Overseers of the Massachusetts Agricultural College."

President Goodell, at the winter meeting of this Board, welcomed the members with these words: "I desire to welcome you in behalf of your college, the Massachusetts Agricultural College, founded under your auspices, nurtured by your care, watched over by you."

The statutes teach us our obligations and define our duties. The appreciative words of the president of the college we believe were not simply complimentary, but just words of deserved praise for the care, the interest, the aid given to this college by this Board. And why is this one college in the State placed under charge of a board of agriculture, and why has this service been gratuitously given for these many years, till the feeble beginning is a grand success? This Board has never forgotten its duty, or failed to help and to sustain in time of need. Money has been given, work has been done, time has been devoted to this college, — why? Because it ever has been, is now and ever shall be the Massachusetts Agricultural College. A distinctive change in name would be a wrong to those noble men, Clark, Wilder,

Knowlton and a host of others, who with self-sacrifice and with money carried this school through its trying years and established it forever. Better had it been wrested from us by the State in '79, than that we, the Board of Agriculture, should allow, or that any of those who have received its benefits should, perhaps with the misguided zeal of an alma mater love, take from it its noblest and most distinctive word, "Agriculture." Such a change would at once terminate our peculiar relation as a board with this college. Its president could not again welcome us in the words I have quoted. It would be no more to us than Amherst or the School of Technology. It would be forgetting the intent and purpose of the land grant by which these colleges were established. They were established for the specific purpose of educating the people in the science and practice of agriculture and the mechanic arts. In most of the States the entire fund was given to one institution, and separate schools of agriculture and the mechanic arts were established. But in Massachusetts the fund was divided, one-third to the Massachusetts Institute of Technology and two-thirds to the Massachusetts Agricultural College, and the State has since generously made appropriations for the support and maintenance of both these institutions.

The wisdom of this arrangement is shown when we consider that both these schools stand in the front rank of all the schools and colleges in the country in their respective lines of work. The Massachusetts Agricultural College is a distinctively technical school,—of the same class as the Massachusetts Institute of Technology,—for the education of the agricultural classes in the science and practice of agriculture.

The successful practice of any of the various lines of agriculture or horticulture requires the broadest and most thorough education of any industrial calling; and the extent and value of the agricultural interests in Massachusetts are of sufficient importance to warrant and demand that at least one well-endowed and well-equipped institution within the State devote its efforts distinctively to the education and advancement of agricultural knowledge, and that the work be carried on as thoroughly and as dis-

tinctly as it is in other technical institutions. The sciences relating to one line of study and their application to the practice of one calling or profession is the central idea of the successful school or college to-day, — the success of the practice depending upon the breadth and thoroughness of that education.

We, the Board of Agriculture, must ever stand, as strongly as our powers permit, against any change in its line of teaching or its distinctive name. We have every reason to be proud of it. Its faculty are above reproach, its teachers are able and ample for the work. The lands, the buildings, the experiment station, the botanical department, the insectary, are models for instruction, and the beneficent results to the agriculture of the State, the country and the world are already its fruits. To-day it is our college, founded under our auspices, nurtured by this Board, watched over by it, and it must not be taken from our care just as it approaches its most perfect development, nor changed in its curriculum, nor hindered in its good results.

Its situation is ideal; the atmosphere of the town is pure as the air from the hills among which it rests. The location of the buildings is artistic, and a view of the college green and of the more distant landscape from the hill in the east is most beautiful and inspiring. Before us is the lovely and fertile Connecticut valley, guarded by those twin sentinels of beauty, Mt. Tom and Mt. Holyoke, while the extended vision takes in the Berkshire hills, with old Greylock looking proudly down upon its surrounding mountains. More northerly the beauty of Franklin County, with Mt. Sugar Loaf and Mt. Toby, holds the eye, till, reaching beyond, it catches the dim outlines of the Green Mountain range.

Brothers of the Board, let us cherish this institution, let us nourish by a more active interest this college. It is yet young, but its present is fruitful and its promise of future usefulness is grand and inspiring. Agriculture is the productive industry on which the prosperity of the State and nation must ever depend, and this college by its work is not only fitting men for future usefulness in every industrial calling and profession, but by its investigations and experi-

ments; its scientific knowledge sustained and proved by nature studies and certain results, it sustains a value to the State unique and peculiar to itself, hinging on that one word "Agricultural." As such we are proud of its past, as such we will maintain it and sustain it in the present; as such we have all faith in its enlarging future for the broadening of knowledge, for the improvement of agriculture and the benefit of the State.

JOHN BURSLEY.

C. K. BREWSTER.

WESLEY B. BARTON.

GEO. P. SMITH.

E. A. HARWOOD.

J. W. STOCKWELL, *Secretary*.

REPORT OF COMMITTEE ON AGRICULTURAL SOCIETIES.

[Adopted at the Annual Meeting, Jan. 10, 1899.]

The committee on agricultural societies held a special meeting at Amherst, on Monday, December 5, to consider the reports of inspectors of fairs. All these reports showed a more careful consideration on the part of the societies of the various recommendations and regulations of the Board of Agriculture.

Certain points are always to be in mind: first, needful sanitary conveniences and care, where large numbers of people are to gather for even a short time; second, careful sifting of applications of various fakirs, who, by one contrivance or another, gather a considerable harvest from the pockets of those who attend the fairs, with very little return; third, careful economy in expenditures, avoiding, as far as possible, risk of large deficit.

The interest of the locality must be depended on to insure the prosperity of any fair, and any attempt to draw from a large circle attendance to meet increased expense is unwise.

During the year but one application for approval of mortgage has been received. This was approved. Your committee believes that, in most cases, deficit should be made good by contributions among the members of the society, rather than by giving security on the property of the society, and it recommends every society to make all reasonable efforts to raise any sum required.

In a single instance among the reports was severe criticism passed upon the efforts of a society to hold a creditable and successful fair; and in one other instance attention was called, though not by the inspector, to unnecessary and undesirable overloading and straining in trial of draft animals.

The conditions of the societies differ widely, and, while Hingham is able to give nine exhibitions in the year, all free, and has no cattle show, and Hillside and some others depend wholly on the old-fashioned cattle show, and are eminently successful, it is evident that all cannot be judged by one standard, but are to be commended for honest and earnest efforts.

W. A. KILBOURN.

N. W. SHAW.

N. B. BAKER.

Q. L. REED.

REPORT OF COMMITTEE ON DOMESTIC ANIMALS AND SANITATION.

[Adopted at the Annual Meeting, Jan. 10, 1899.]

The committee, being unable to arrive at any definite plan it would care to recommend, suggests to the Legislature that, as the Cattle Commission is at the present time inoperative, a certain sum be appropriated sufficient to carry on the work in a conservative manner, special attention being paid to sanitary conditions.

ISAAC DAMON.
O. S. THAYER.
JOSHUA CLARK.
F. L. WHITMORE.
A. W. LLOYD.

REPORT OF COMMITTEE ON EXPERIMENTS AND STATION WORK.

[Adopted at the Annual Meeting, Jan. 10, 1899.]

A careful examination of the Hatch Experiment Station cannot fail to convince any thoughtful person that a large amount of labor, directed by intelligent thought, has been expended in fitting up each department with apparatus well adapted to the work which it is required to do.

The farmer who has never visited an experiment station or attempted to try an agricultural experiment can have but little conception of the well-matured thought, careful, intelligent action, and the expensive apparatus, necessary to establish such new facts as will enable the farmers, in the near future, to feed their plants and their animals better and cheaper than they ever have in the past. That something has already been done in this direction, some of the farmers know; but many of them do not seem to realize that in every department work is being done that without doubt will, in a few years, be a great help to every intelligent tiller of the soil.

In the department of entomology, a wonderful work has been done in collecting and classifying the numerous insects which injure, and those which benefit, the farmer. From this department important information is sent out every year that aids the farmer in his efforts to save his crops from destruction by insects. As new destructive insects are continually making their appearance, frequent applications are made to this department by the farmers for information that will aid them in their efforts to protect their crops. Could we ascertain the value of the crops saved every year by the use of the information sent out from this department, it would, no doubt, exceed the cost of the plant and its running expenses. Your committee believes that this de-

partment is so important that whenever it becomes necessary to go outside of the station to study the habits of a new destructive insect, and make experiments to learn the best methods for its destruction, special appropriations should be made to defray the expenses.

Since the establishment of the first experiment station, much has been done in the direction of testing soils and feeding plants. This is a work which opens a broad field for investigation, and one which, to be conducted to the best advantage, should be under the supervision of one whose mind is not distracted by outside work which has but little if any relation to the experiments under trial; in fact, nearly all experiments which are being tried or are likely to be tried in any department of the station, require so much intelligent thought to decide along what lines the next work should be pursued, and such correct measurements, watchful care and good judgment to secure correct conclusions, it is to be regretted that the station is not supplied with ample funds to secure the whole time, and the undivided attention of the professors at the head of each department.

Many experiments have been and are yet being tried, to ascertain the best and cheapest forms of plant food for the growth of various plants. While this is one of the most important branches of the work with which the station has to deal, it is one of the most difficult; and it is impossible to make a formula that would give uniform results when applied to different farms, because the plant food which is available for plant growth on one farm may be quite different from that which is available on another farm, at no great distance. While the soil on one farm may be almost entirely deficient in available potash, that on another farm may be very rich in available potash, thus causing a formula cheap and well adapted for one farm to be much more costly than it need to be and yet not adapted to the other; therefore, while we are getting some valuable information from this line of experiments, we must not expect too much with the means which are available in this department.

Another line of work which seems to be closely connected with this department is that of the discovery of some cheap compound, which, on application to the soil, will make

available for plant food the phosphates and the potash which by ordinary methods are unavailable. This and the compounding of the different formulas for plant food require the intelligent thought and careful work of the chemist; and it seems to your committee that the entire work should be under his supervision, and also a special appropriation should be secured, to make such additions as may be necessary to do well the work which is so desirable to be done in this department.

Much work has been done in testing foods for feeding animals, to ascertain the most desirable plants to be grown, and the combinations which will secure the best results. Careful experiments are now being made to ascertain if cows, by any change in their food, can be made to give milk of a richer quality. As this is a disputed point, the result of this experiment will be looked forward to with interest by all dairymen.

The department which has had under investigation the subject of fungi has done much to help the farmer to protect his trees and plants by spraying with compounds that experiments have proved to be best adapted for the work.

The horticultural department shows continual progress; from it fruit growers can get reliable information relating to the value of different varieties of fruit, and what trees, shrubs and plants are hardy enough to endure our winters. Some of the work laid out for the coming year is in the direction to furnish an object lesson which will be of interest to all intelligent visitors.

If any fault is to be found with any person or persons, it is with the farmers of the State, or that portion of them who fail to keep in close touch enough with the station, to realize the importance of the work being done at the station, and thus fail to get that information which they need to increase the profits of their farms. Farmers, you cannot afford to be without the information which this station is able to give; and every year that you try to run your farms without it will increase the distance between you and the successful farmer, who carefully reads the reports of the Hatch Experiment Station.

EDMUND HERSEY,

Chairman.

REPORT OF COMMITTEE ON FORESTRY, ROADS AND ROADSIDE IMPROVEMENTS.

[Adopted at the Annual Meeting, Jan. 10, 1899.]

Having reported to you verbally for the committee on forestry, roads and roadside improvements, and having received your permission, by your vote, to report in manuscript the several subjects upon which I spoke to you, I now do so.

During the past year I was invited to preside at a number of meetings held in Boston, at which efforts were being made to formulate a plan upon which a Massachusetts Forestry Association could be established, whose charge should be to aid in advancing the condition of, and improvement in, our State's forestry condition.

I consider that the fact that you had done me the honor to place me as chairman of your committee, which included that subject, was the reason that I was asked to endeavor to guide that effort, which has met with success, and will, let us hope, become a factor in the direction sought, and will be of much benefit to the State's forestry and kindred interests.

During the past winter, when the matter of protecting the beauty of roadside scenery against near-by excrescences of advertising signs and sign boards was being considered by the Legislature, I appeared before the committee having the matter in charge (judiciary committee), and favored the proposed law, so far as in the judgment of that committee it was constitutional.

The early form of the proposed bill was thought to be too extreme, and did not meet with approval, nor did the amended bill meet with final approval in our legislative branch. The committee in charge gave careful hearings and

heard many people, and their report appears to have been misunderstood. The same subject is before the present Legislature, and it is to be hoped that it may become a law.

During the past summer the American Forestry Association met in Boston, together with the American Association for the Advancement of Science, and all the members of this committee were authorized to attend said meeting. I regret that it was not then possible for the full committee to assemble with us, I being president of said association, in Horticultural Hall, and participate also in the excursions.

Papers were there read and remarks made by men in high authority upon forestry matters, some of whom had been trained in the best forestry schools in the world, and who had held high positions in this country and abroad.

During the past year the Massachusetts Horticultural Society has established a permanent committee on forestry and roadside improvement; but, while the committee is composed of men of high rank in such matters, they have not found the opportunity for action during the year. It is expected that they will be heard from to the State's good during the next year.

The Department of Agriculture at Washington has, during the past year, instituted a plan to try to advance knowledge of the care of woodlands, so as to better protect them against fires, and to make them more profitable as timber to their owners. I suppose their prospectives are upon the shelves of our Board's library, where they can be seen to tell their story better than I can here give it; or they can probably be secured from the Forestry Division of the Department of Agriculture at Washington, upon receipt of postal card request.

The law permitting the election of town foresters has been found in some places to have worked extremely well, where some one was needed to give thought to the treatment of roadside trees and shrubbery, who would give the necessary time to the work. Those foresters who could work in concurrent understanding with the town's authorities, and in true harmony of intent, have met with success in this work, but at times the office has been locally found an unwise creation.

What has seemed to me a most commendable effort, not only in the study of road making, but which has proved a certain system of road making a success, has been put in operation by the Metropolitan Park Commission in their park roads in the neighborhood of the city of Boston. It is a simple process, where the natural material is favorable, and where the grades have been established in accordance with figures that experience has proved to be wisest. The system consists of crowning the road surface to meet existing conditions, and of not too great a width, and then having it well rolled by a heavy steam roller. I refrain from giving figures, as I believe that in all such cases it is wisest to secure the advice of men trained, and proved able, for such work.

A good road is one of the best promoters of value and profit that can be created, when well done; but much money has been wasted in our own and other States by the treating of road surfaces unintelligently. Should a State Bureau for the dissemination of free advice in this direction be established, it would seem to be of much value to the several towns in the State.

Respectfully submitted,

FRANCIS H. APPLETON,

Chairman.

REPORT OF THE LIBRARIAN.

[Adopted at the Annual Meeting, Jan. 10, 1899.]

To the Secretary of the State Board of Agriculture.

SIR:—In presenting the second report of the librarian, it is desired to refer briefly to the recommendation made in the first report, namely, “That there be prepared for publication in the ‘Agriculture of Massachusetts’ a catalogue, giving titles, authors and other customary items,” which recommendation was adopted by the Board at its annual meeting, held in January last; the Board further voting “That the catalogue be published in the ‘Agriculture of Massachusetts’ which is published next after the completion of the catalogue.”

The work of the librarian the past year has been largely the perfecting of the classification of the library and the preparing of the above-mentioned catalogue, which is now respectfully submitted as an Appendix to this report.

A brief history of the library was given in the librarian’s report of a year ago, and reference was there made to the only catalogue of the library heretofore prepared, and which was printed in the “Agriculture of Massachusetts,” 1857, pages i-xxix of the Appendix.*

Probably the first original treatise on American farming was the work of Charles Varlo, Esq., of Philadelphia, published in that city in 1785. This work is in two volumes, and is entitled, “A new system of husbandry from many years’ experience.” A book often referred to as being the first original American work on agriculture is entitled, “Arator, being a series of agricultural essays, practical and political.” Its author was John Taylor, and it was printed at Petersburg, Va., in 1818.†

* Agriculture of Massachusetts, 1897, page 197.

† Board Bulletin No. 7, library number, season of 1898, Maine State Board of Agriculture.

The late Charles L. Flint, for so many years the secretary of the Massachusetts State Board of Agriculture, in his twenty-first annual report (1873) included a paper on "A hundred years' progress of American agriculture." In this paper, speaking of our agricultural literature, he said : —

The permanent agricultural literature of the country, now so extensive and so creditable, has grown up, for the most part, within the last twenty years. A few books of a high character appeared, from time to time, forty or fifty years ago, . . . but a large proportion of the farmer's reading, previous to 1850, consisted of English works, many of which were reprinted in this country. Since that date American treatises, in the highest degree instructive and useful, have appeared, and we have works upon landscape-gardening, fruits, animals, dairy-farming, drainage, and, in fact, upon subjects covering the whole range of farm economy, many of them of unexceptionable literary merit in point of style, finish and perfection, and the results of accurate scientific research. To bring the facilities for improvement within the easy reach of the largest number of people, the system of township and district libraries was first initiated by the State of New York, in 1837. . . . This example was followed by Massachusetts in 1839. . . . Indiana adopted the same policy in 1854, Ohio in 1857. . . . At the same time most of the States early adopted the plan of publishing and distributing large numbers of documents upon agriculture, gratuitously, among the people. These documents are, many of them, of high merit, containing the most recent scientific investigations, reports of experiments, and the observations of the most experienced practical men.

It may be added, in passing, that all of our experiment station literature, most of the publications of the United States Department of Agriculture, and most of the reports of boards and societies organized to carry on certain lines of work pertaining to agriculture, horticulture and kindred sciences, are the product of the past quarter of a century. What progress since Mr. Flint penned the lines quoted above ! An examination of the appended catalogue of the library of this Board will reveal much of this progress, which indeed has been truly wonderful.

During the past few years frequent requests have been made by institutions of various kinds, and by individuals,

for back volumes of the "Agriculture of Massachusetts," and it has been the practice to grant such requests whenever possible. The past year was no exception to the rule, and the librarian found considerable employment in answering such calls and in replying to requests for information on various subjects, as well as in keeping the run of the many publications received from time to time in exchange.

One of the pleasantest of these requests was from a gentleman in Natal, South Africa, who stated that some years ago he received from the late American Consul in Natal—his grandfather—a copy of the twenty-eighth annual report of the Massachusetts Board of Agriculture (1880), and who further stated that "of so much value has this interesting publication been to me and other farmers in Natal, that I am venturing to ask you whether you will be willing to confer a great kindness on us by forwarding me the subsequent publications (or such of them as you can spare) from 1881 to 1897." Certain volumes were sent the gentleman, and in his letter acknowledging their receipt he wrote: "These indeed bespeak great advancement in your agricultural industry since 1881. It is my intention to make public in Natal much of the valuable information contained in the volumes you have sent me."

Another interesting communication was from the managing editor of an agricultural paper published in a neighboring State. This gentleman delivered a lecture before the Board of Agriculture at Taunton about a year ago, and in his letter he wrote as follows: "I would like to ask you about how large a circulation you have for your annual report. It is a singular thing that I am receiving a great many letters from various parts of Massachusetts from persons who say that they have read the report of my little talk at Taunton. I have also a letter from a man in Montana, which came as a result of reading this report, and I would really like to know about how large a circulation you give, in order to call out so many letters."

Some work has been done on the card catalogue of subjects referred to in the last report of the librarian, and there are now on hand 1,080 such cards. The subject index of the literature of agricultural experiment stations and kindred

institutions, supplied by the Department of Agriculture, now comprises 17,000 cards, covering the years 1887-96.

Something has also been accomplished in the line of perfecting broken or incomplete files of publications, and in the binding of bulletins and pamphlets into convenient volumes for the library shelves. Also the library shelves have been supplied with shelf label holders.

The expenses incurred on account of the library during the past year were as follows: books and pamphlets purchased, \$146.76; current publications subscribed for, \$48.81; binding, \$83.50; supplies, \$69; total, \$348.07. These expenses were paid from the appropriation for "incidental expenses in the office of the secretary."

Respectfully submitted,

F. H. FOWLER,

Librarian.

APPENDIX.

CLASSIFICATION AND CATALOGUE OF THE LIBRARY OF THE MASSACHUSETTS STATE BOARD OF AGRICULTURE.

ROOMS 134-136, STATE HOUSE, BOSTON.

	Vols.
DIVISION I.—Publications of the United States Department of Agriculture, ...	145
DIVISION II.—Experiment Station publications, ...	161
DIVISION III.—General library, ...	2,657
Total, ...	2,963

DIVISION III.

	Vols.
CLASS I. Agriculture, reports, etc., ...	996
II. Agriculture, theory and practice, ...	269
III. Horticulture, ...	295
IV. Domestic Animals, ...	211
V. Natural sciences, ...	299
VI. Statistics, ...	236
VII. Education, ...	185
VIII. Miscellaneous, ...	166

CLASS I.—AGRICULTURE, REPORTS, ETC., ...	996
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	Vols.
Sect. 1. Boards of agriculture, etc., reports, ...	450
Sect. 2. Agricultural societies, transactions, ...	284
Sect. 3. Farmers' institutes, proceedings, ...	18
Sect. 4. Crop reports, ...	5
Sect. 5. Grange proceedings, ...	6
Sect. 6. Dairy associations, etc., reports, ...	25
Sect. 7. Produce exchanges, etc., reports, ...	12
Sect. 8. Agricultural journals, etc., ...	196

CLASS II.—AGRICULTURE, THEORY AND PRACTICE, ...	Vols. 269
Sect. 1. Agriculture, theory and practice, ...	115
Sect. 2. Manures and fertilizers, ...	17
Sect. 3. Drainage and irrigation, ...	18
Sect. 4. Farm implements, machinery, buildings, ...	16
Sect. 5. Field crops, ...	37
Sect. 6. Market gardening, vegetables, mushrooms, ...	21
Sect. 7. Glass houses : construction, management, crops, ...	7
Sect. 8. Milk, butter, cheese, ...	8
Sect. 9. Bees and bee keeping (apiculture), ...	30
CLASS III.—HORTICULTURE, ...	295
Sect. 1. Horticultural societies, etc., transactions, ...	63
Sect. 2. Horticulture, general works, ...	26
Sect. 3. Flowers (floriculture), ...	32
Sect. 4. Forestry (arboriculture), ...	35
Sect. 5. Landscape gardening, rural architecture, ...	27
Sect. 6. Botany, vegetable physiology, ...	42
Sect. 7. Plant diseases : fungi and fungicides, ...	6
Sect. 8. Grapes (viticulture), ...	6
Sect. 9. Fruits (pomology), ...	58
CLASS IV.—DOMESTIC ANIMALS, ...	211
Sect. 1. Cattle, breeds, herdbooks, ...	47
Sect. 2. Cattle raising, (dairying), ...	41
Sect. 3. Veterinary science, animal diseases, ...	47
Sect. 4. Sheep and wool, ...	23
Sect. 5. Swine, ...	3
Sect. 6. Horses, ...	33
Sect. 7. Dogs, ...	3
Sect. 8. Cats, rabbits, etc., ...	3
Sect. 9. Poultry (aviculture), ...	11
CLASS V.—NATURAL SCIENCES, ...	299
Sect. 1. Chemistry, ...	37
Sect. 2. Geology, mineralogy, soils, ...	24
Sect. 3. Natural history, zoölogy, ...	45
Sect. 4. Biology, evolution, etc., ...	5
Sect. 5. Insects and insecticides (entomology), ...	75
Sect. 6. Birds (ornithology), ...	34
Sect. 7. Climate, weather (meteorology), ...	13
Sect. 8. Fish and fish culture (pisiculture), ...	10
Sect. 9. Smithsonian Institution, etc., reports, ...	56

CLASS VI.—STATISTICS, ... Vols.
236

	Vols.
Sect. 1. Agriculture, ...	21
Sect. 2. Manufactures, ...	22
Sect. 3. Labor, ...	38
Sect. 4. Transportation, commerce, ...	32
Sect. 5. Finance, ...	30
Sect. 6. Taxation, revenue, ...	13
Sect. 7. Population, social, ...	18
Sect. 8. Public health, ...	18
Sect. 9. Miscellaneous, ...	44

CLASS VII.—EDUCATION, ... 185

Sect. 1. Education, reports, ...	17
Sect. 2. Educational institutions, reports, ...	8
Sect. 3. Encyclopedias, ...	41
Sect. 4. Dictionaries, ...	17
Sect. 5. History, ...	37
Sect. 6. Biography, ...	5
Sect. 7. Atlases, ...	6
Sect. 8. Hand books, ...	18
Sect. 9. Almanacs, calendars, ...	36

CLASS VIII.—MISCELLANEOUS, ... 166

Sect. 1. Law, ...	63
Sect. 2. Highways, roads, ...	8
Sect. 3. Peoples, customs, ...	9
Sect. 4. Food of man, ...	6
Sect. 5. Mechanics, engineering, ...	8
Sect. 6. Heating, ventilation, ...	10
Sect. 7. Political economy, ...	9
Sect. 8. Library, ...	6
Sect. 9. General miscellany, ...	47

NOTE.—At the annual meeting of the Board the vote of last year concerning the printing of the catalogue was reconsidered, and it was—

Voted, That the catalogue prepared by the librarian be printed separately, in such form as shall be decided by the secretary and the chairman of the executive committee, at an expense not to exceed \$200, the same to be paid from the appropriation for incidentals or for dissemination of useful information in agriculture. It is expected that the catalogue will be printed within a very few months, and, while the distribution will not be general in character, it is hoped that all interested persons or institutions wishing a copy may be supplied.

THE MASSACHUSETTS AGRICULTURAL COLLEGE: ITS CRITICISMS, ITS BENEFITS.

BY C. K. BREWSTER, WORTHINGTON.

Thirty-eight years ago, when the nation was passing through the most trying ordeal in its history, the late Hon. Justin S. Morrill of Vermont introduced a bill, which passed through Congress, providing for the sale of public lands for the purpose of establishing agricultural colleges in different States. From the sale of the 360,000 acres of the public lands allotted to Massachusetts was realized the sum of \$208,464. In 1871 this amount was increased by the Legislature of Massachusetts to \$360,000, the whole constituting a perpetual fund, two-thirds of the income to be paid annually to the treasurer of the Massachusetts Agricultural College, and one-third to the treasurer of the Massachusetts Institute of Technology. Twenty-five years later a second act of Congress established with each college an experiment station, with an annual endowment of \$750,000. Three years later another bill provided for an annual grant to each college established, commencing with \$15,000 and increasing each year \$1,000 till the maximum of \$25,000 had been reached. This was divided as before, to wit, two-thirds to the Agricultural College and one-third to the Institute of Technology. These facts you are doubtless familiar with, and will find more elaborately stated in the opening of the thirty-fourth annual report of the Massachusetts Agricultural College.

The establishment of these colleges seemed to provide for a long-felt want, in that it offered opportunities to a class of people as students and patrons that were not able to make use of the older and more classical institutions. Long ago Aristotle said, "The salvation of a country in a crisis must lie in its middle classes," and these institutions seemed to

furnish an opportunity for the middle classes that was not found elsewhere. Broad in conception, broad in character, broad in opportunities and broad in acres, the agricultural college fits men in a practical way to meet the demands of the times. President Goodell, in the report above referred to, says: "Many of the youth received their entire support from home, but many others are supporting themselves by their own exertions, almost or wholly unaided, and many others come from homes where every dollar contributed to the education of a son involves some appreciable sacrifice."

During the years of its history the college and its work have been marks for the shafts of criticism. It is often said that the accomplishments are not commensurate with the costs; that the classes are small; that, while ostensibly for the benefit of agriculture, its real tendency is in other lines; that a majority of the senior class, who have their option during the last year of the course, do not choose agriculture; that it is a great barnacle upon an over-taxed public administration. Are these criticisms born of intelligence? Are they just? If I do not answer them in considering the last clause of my subject, then I cannot answer them at all.

Let us step outside of its general school work, its curriculum, its care and training of young men, which will compare favorably with other institutions, for the present, and trace some of the numerous benefits that accrue to the farming communities.

Conditions among the farmers have almost completely changed since the early history of our State. Microbes have supplanted ghosts. Gypsy moths have supplanted witches. Pests innumerable have manifested themselves, to the discomfiture of the horticulturist, the market gardener and the farmer. Misfortunes have come to the farm and the forest along the line of advancing years that formerly did not appear,—tuberculosis and other diseases, the gypsy moth and canker worm and fruit-destroying parasites, that have called for skilled labor and experiments in the field of entomology. In other words, we have been obliged to combat these myriad pests by checks and counter-checks and checks drawn upon the State Treasurer.

To the skill of the Massachusetts Agricultural College we have looked for help in the emergency, and not in vain. Its work in this line cannot be measured in dollars and cents. It has been invaluable to the farming interests of this Commonwealth.

Again, a great benefit that accrues to the farming interests of this Commonwealth, and especially of western Massachusetts, comes from the personal presentation of agricultural subjects and experimental results directly before the people at agricultural institutes, where different subjects are presented by some member of the faculty, and usually followed by a discussion. Such subjects as soiling crops; comparative commercial value of different feeds and fertilizers; mixed rations, and their results; relative value of different grasses and grains; system of farming best adapted to increasing the fertility and productiveness of the soil; the system of farming best calculated to increase, improve and utilize farm manures; rotation of crops; the clover plants, their value and importance in farm economy; the scientific and practical way of improving the butter qualities of the dairy cows; laws that especially pertain to farmers' interests; horticultural matters, and other kindred subjects. These lectures come directly before the people, and stimulate thought and investigation that are showing marked results in many ways. Then, too, the lectures add new dignity to the farmer's vocation. They inspire the people with the idea of being co-workers with nature in bringing forth benefits for the people. They give new vitality to the æsthetic side of our lives, so that we see more and clearly that which is beautiful and interesting in the natural development of crops and fruits and flowers. They open the way to feel the invisible touch of that power of life which renews itself in growth. Along with practical suggestions, they add new beauty to the landscape and new spirit to the words of the sweet poet who wrote, —

“ He who plants a tree, he plants love,
Tents of coolness spreading out above
Wayfarers he may not live to see.
Gifts that grow are but
Hands that bless, are blest;
Plant! Life does the rest.”

The Hon. Jerry Rusk well said, "Let it be the glory of the great American people to make science the handmaid of agriculture."

Professor Henderson of Chicago University says: "Education is not merely preparation for life, it is life. To make manual work honorable, we must give it rank and place along with literature, history, art and classics, and thus associate the useful occupations inseparably with ideal pursuits." Horace Mann said: "Remember that the learning of the few is despotism, the learning of the multitude is liberty, and that intelligent and principled liberty is fame, wisdom, power. The well-educated operative does more work, does it better, earns more money, commands more confidence, rises faster and to higher posts in his employment than the uneducated workman can." And this is what we claim this college is doing among the farming people. She is pointing to the future calling of the farmer, and not away from it. Science as an abstract thing is useful to only a few; but when science, extracted from close research, study and investigation, is put before the people for popular practical use, it becomes a blessing and an educator; and this is a part of the work of the college.

Farming to-day is more of a science than formerly. The successful farmer must make every day a school day; must open his mind to new ideas; must be a constant learner in the labor of life and the laboratory of nature; must know more about his calling than his ancestors, or he will surely go to the wall.

It is to the general auxiliary work of the institution that I would call especial attention. President Goodell, in his report for 1897, thus quaintly alludes to some of the work of the college: "The farmers are coming more and more to depend upon the college, and what is true now is just as surely going to increase in the future. In nothing does this more strikingly appear than in the matter of correspondence. During the last twelve months 5,528 letters have been answered in the experiment department alone. What does this mean? It means that at 5,528 points we have touched the interests of the agricultural life of this State. It means that 940 dairymen have wanted to know about butter fats, or

the best-balanced ration, or the hundred other matters of vital interest. It means that 750 farmers have had questions to ask concerning fertilizers and fertilizer materials. It means that 316 intelligent men engaged in the practice of agriculture have wanted information respecting rotation of crops, millets and soya beans, or the effects of potash on the growth of corn. It means that 304 fruit growers have come and asked what were the best varieties of fruits, how to cultivate them and how to prevent disease,"—and various other matters that may be found in said report. This, too, in one department alone. It may be seen, therefore, that the work outside of the college and its broad acres is large, varied and beneficent. And, while this work is being carried forward in the line of public benefit and general advancement, a grander work, perhaps, is being done within the college bounds in developing men who will go out into the world to leaven its interests, and especially its farming interests, with new ideas and new methods.

Humboldt has well said, "Earth holds up to her maker no fruit like the finished man."

The value of agricultural college work cannot be measured by the graduates who follow farming alone, as a profession. The school training will also develop the bent of natural talent and taste. If the student has the making of a leader in any walk of life, he will drift in due season into his proper channel; and these leaders are often found to start from simple, humble homes. In referring to agricultural colleges, the late Phineas Stedman in a written article said: "I consider that no cause is better calculated to promote the welfare and future progress of agricultural practice than a general diffusion of a knowledge of the sciences connected with agriculture. Our endeavor should be, and the tendency of the institution is, to impart to the tiller of the soil that knowledge which has hitherto been possessed only by the scientist."

Ah, but some one says, these, the finished men, or the leaders in thought and enterprise, do not come from rural conditions and farmers' homes. Let us consider.

Buckle, the noted English writer, tells us that "the characteristics of men are fashioned and shaped largely by the

aspects of nature which environ them." If this be true, certainly Amherst offers inviting features to develop large men. Hill and valley, mountain and meadow, flower and fern, fruit and foliage, lake and landscape, art and nature conspire to make it the Mecca for farmers' sons. Many a time I have stood upon Clark's Hill, the eastern boundary of the college grounds, and drank in the beauty of the situation. At your feet the college farm, bestudded with horticultural art; farther away the fertile valley of the Connecticut; in the north, Mount Toby; in the south, Mount Holyoke and Mount Tom, standing against the sky like mighty watch towers guarding the western range of hills dotted over with farmers' homes. Have these farmers' homes sent out into the world men of broad, strong minds and keen intellect? Let us see. For an illustration let us take the western hills of Franklin and Hampshire referred to, — a rugged, hilly country, away from railroads, away from advanced classical schools, away from the benefits of libraries and laboratories such as the large towns possess.

Within a radius of ten miles from the birth spot of William Cullen Bryant, which is now marked by a granite monument in the town of Cummington, to illustrate my point, I quote a little local history. The town of Ashfield was the birthplace of Dr. G. Stanley Hall, now at the head of Clark University. For several years during his boyhood his father lived in my native town, upon a farm that was his only means of support, which would not sell for \$1,500. I believe Dr. Hall is regarded as one of the most profound scholars of modern times.

Step across the rugged hill top, if you please, to the little town of Plainfield, with its 450 inhabitants, and there we will find the birthplace of Charles Dudley Warner, who has built for himself in the world of literature a monument grander than that of marble or granite. There, too, was the early home of Professor Lincoln, both sons of hardy farmers.

Then, across the eastern branch of the Westfield River, to the birthplace of America's famous poet, and to the place from whence was given to the world "Thanatopsis" and the "Rivulet." The great poet of nature here on his father's farm (although his father was both physician and farmer)

breathed his inspiration and fed his soul from nature's storehouse, so that out of his noble heart and great intellect came gems of thought, clear and chaste and beautiful, that will go down the ages like diamonds upon the bosom of literature. Who that loves the music of poetry, or the song of a crystal spirit, or the touch of a master hand, does not feel the richer for the life of William Cullen Bryant? Here, too, in the same neighborhood was born and reared that astute lawyer and statesman, Henry L. Dawes, who for eighteen years represented his district in the National House of Representatives, and for eighteen years Massachusetts in the Senate of the United States.

The little town of Middlefield, with its 386 inhabitants, has given many able men to the world, of whom I might mention Dr. Judson Smith, secretary of the Board of Foreign Missions, whose recent travels in China will do much to open her gateways to the light of the western continent. This little town has to-day a professor and two members in the Massachusetts Agricultural College.

Worthington has furnished two mayors for the city of New York, in the persons of Gideon Lee and Dr. Aaron Clark; a chief justice for the State of Kansas, in the person of Samuel A. Kingman; and Prof. Harmon Niles, the noted naturalist of Cambridge; and Russell H. Conwell, the famous preacher and lecturer of Philadelphia, whose annual income represents more dollars than the combined worth of all their fathers' estates.

These small contiguous farming towns to which I have referred had a population in 1895 of 3,247 inhabitants; and, while I would not make invidious comparisons, I would like to have any one cite a contiguous territory in any city of like population that ever produced such a galaxy of great men.

All these I have mentioned were sons of farmers of small means, — men who struggled among the middle classes in their rural country homes; out of the loins of tillers of New England soil; out from the way-back hill tops, where the air is not infested with noxious vapors, and the water is as clear as a September sky, these strong men have come.

The men who have moved the world in thoughtful aspiration in the nineteenth century have sprung largely from

these rural farms and rugged environments. History is ever repeating itself. May not the generous hand of Massachusetts and the Massachusetts Agricultural College be the uplifting power and avenue to usefulness, power and honor for generations yet to come?

We are at the close of the nineteenth century. Mighty events in history of remarkable character have filled the year just closed. I am one of those who believe that the mission of this country is not to inclose itself in a shell, but to push its mighty power in the advancement and civilization of the world, so that men of every nationality may be brought into a better condition morally, intellectually and commercially. And I further believe that this country of ours, with its marvellous resources, its great wealth, its educational advantages, fails of its high destiny if it does not leaven the whole world with its advanced ideas and attainments. Galileo was arrested because of his advanced ideas; Columbus was returned to Spain in chains; Garrison was imprisoned because of his anti-slavery sentiments; Lovejoy tasted death because of his faith in equal rights. They each in turn wrought a mighty work. It may be that McKinley and his compeers are building better than they know or realize; that before us in the close coming years is to be a mighty march of events, led by the Anglo-Saxon race. If it is the destiny of this country to open the way to a higher civilization in the West Indies and the Phillipine Archipelago, with its 10,000,000 inhabitants, and to introduce new methods and ideas in farming and procuring the natural benefits of the wonderful climate and soil, who will be better equipped to lead the work than the graduates of the agricultural colleges? They are men of practical knowledge. Thoreau said, in one of his books: "Why! to my astonishment I was informed on leaving college that I had studied navigation. If I had taken one trip down the harbor I should have known more about it." These men, speaking figuratively, have not only studied navigation, they have taken the trip down the harbor. Their training is in a practical line.

With all the modern facilities for travel and communication, is not the way opening for a great missionary work in

the name of God and humanity for many a farmer's son, thrilled with the spirit of the "Mayflower," the spirit of '76, the spirit of Lincoln and Maceo, the spirit of Captain Dickinson of the college as he bravely met his death while crowning the heights of San Juan? This country has been blessed beyond any other in growth, prosperity and resources. Shall she infold herself in selfish luxury, and supinely wait for the world's laurels to be brought to her; or shall she press her enterprise and light among the millions who sit in the shadows of the mediæval ages?

History says it was the policy of Metternich, the great Austrian statesman, "neither to innovate nor to go back, but to keep things as they were." This is not the spirit of the age. It is not American. Men may talk of expansion and anti-expansion, imperialism and anti-imperialism, yet the irresistible fact remains that the world belongs to civilization; and I predict that before the end of the first quarter of the twentieth century the dark portions of the earth will be under the governing power of civilized people, and that the United States, with her millions of school-trained men and women, will be the principal factor in blazing the way for the mighty "manifest destiny."

Three years ago when I was accorded the junior place on the committee of education and Massachusetts Agricultural College of this Board, I entered the service with a prejudice against the institution. That prejudice has changed to admiration. I see now that it was the needful link in our system of education. It touches thousands of people at vital points in a practical way. It reaches out a helping hand to the farmers and to the farmers' boys, and to others who could not reap the benefits of the older colleges. It invites those strong natural parts, that with culture and training can attain commanding positions in life. I believe its influence is being strongly felt all through the State, not only upon the farms, but in the marts of business, in the halls of legislation, at this Board, and in a thousand ways which we hardly sense or realize. Yet it ought to have a larger influence. I am told it has a capacity for about three hundred students. It has a little above a hundred. The demand for trained men in agricultural matters is larger than the supply.

In yonder elegant public library building the hand of the late French artist painted as a central composition "The Muses greeting the Genius of Enlightenment," with panels representing astronomy, chemistry, physics, history, philosophy, etc. These are significant but symbolical. What the country needs to-day is young men of physical strength and courage, combined with mental culture and noble purposes, living practical pictures, to carry the "Genius of Enlightenment" to the four quarters of the earth, and particularly the science of our western agriculture. Every tax payer in Massachusetts is in part a proprietor of this institution. Every farmer is, or should be, an interested factor. This Board, as the representative of the agricultural interests of the State, ought to use its opportunities and influence to make its work familiar to the people, to enlarge its patronage, and to make its work appreciated and successful.

A word of tribute, and I am through. An honored head lies low. The captain of our theme, the great father of agricultural colleges, has lately fallen by the way. From the Senate of the United States, after a long and useful service, he has passed to the "city of the dead." "The sighing of sister States, respondent in their grief, is heard in all the land." May every college boy that feels the blessing of his great work be ennobled by his character, be exalted by his integrity and inspired by his manhood, and remember with filial gratitude the hand and heart that prepared the blessing, and so keep fresh and tender and fragrant the memory of the illustrious statesman, Justin S. Morrill.

FUTURE OF MASSACHUSETTS AGRICULTURE.

BY N. I. BOWDITCH, FRAMINGHAM.

Members of the State Board of Agriculture, at this time we are called upon to look well to the future of the agriculture of Massachusetts.

Massachusetts cannot rightly be called an agricultural State, but why should she not take the lead in the science of agriculture, as she does in other things, and be looked up to by the other States of the Union?

This Board has done great work, and is doing it now ; but I think you will agree with me that the work can be broader and more improved, and that it should be undertaken at once. The reorganization of this Board has got to come in the near future, to bring it down to a smaller number, in order that its work may be broadened and improved. To this end I would suggest the following plan : —

As the State is divided into thirteen districts to-day, according to population, let each agricultural society in a district send one representative to some central chosen point, and all the representatives from the different societies there assembled choose one to represent their societies on the Board of Agriculture. In this way there would be elected thirteen members of the Board. Add to these, either by election of the Board or appointment by the governor, six specialists, viz., a chemist, an entomologist, a botanist, a veterinarian, an engineer and an ornithologist. These should be *ex-officio* members of the Board, beside the governor and the president of the Agricultural College, as at present, and also a secretary, who should be elected by the Board. In this way you would have a board of thirteen members, six specialists, with the governor, secretary and president of the Agricultural College, making, all told, twenty-two members.

At present there are forty-nine, counting members *ex-officio* appointed by the governor and council, and specialists.

I should advocate the withholding of all bounties from those societies holding an agricultural circus; they may cause some amusement to the farmer, but the side shows are very demoralizing to his sons, as they are generally nothing but travelling rum shops. This money could be used to much better advantage by putting good men in the field, who would visit the farmer personally and show him how he could better his condition.

The Massachusetts farmer is very hard to move and takes much coaxing, and then moves slowly. He can be waked up and started by this Board, and it is the duty of the members to see to it that he is. Why should forty per cent of the milk used in Boston come from outside the State, or so many vegetables come to our markets from the west? They are no smarter there than we are here, but they are quick to see an opening for all their products. With good men in the field going about among the farmers of this State, showing them the advantages of balanced rations, how they could save money in making milk, teaching them hygiene, fruit culture and spraying, and many other things to their advantage, I believe the money would be more than well spent, and this Board would come in closer touch with the farmers than ever before.

Our present secretary has served us earnestly and faithfully, but he could not do more until our system is changed. As this change is bound to come in the near future, let us make a move in the right direction, and be on the watch for a future secretary, a young man with a good broad scientific education, one that will be popular with the farmers and lift them out of the ruts they have been in so long, and make them think.

BULLETINS

MASSACHUSETTS BOARD OF AGRICULTURE,

PUBLISHED IN

MASSACHUSETTS CROP REPORTS, 1898.

NATURE'S FORESTERS.

BY E. H. FORBUSH, ORNITHOLOGIST TO THE BOARD.

Who can tell us of the beginning of vegetation upon the earth, of the evolution of the forest from the rank growths of the swamps of early periods? Who can even write the story of the forests of to-day, from the seed sowing through the cycles of years to the tottering and fall of the last giant trunk as it goes crashing to the forest floor to crumble in dust amid the fragments of its fellows? How is the forest planted? Somewhat of this we know. Wind, stream and wave are the bearers of the seed; crow, jay, thrush, mouse and squirrel are the forest planters. But, say you, the trees bear fruit, and if the seed fall on good ground, the rains will come, the sun will shine and the seed will spring up and bear fruit according to its kind. True, but if acorns fell to the ground only beneath the oak, there would be no wider dissemination of the seed than could be thus accounted for, and we know that oaks spring up as if the seed were sown broadcast. Let us watch the sowers of the seed, and so learn how it is scattered over the land.

PLANTING THE FOREST.

If you take a white pine cone with seeds, break it open and examine a seed, you will find that it is enveloped in a membrane with a wing-like appendage. Now take the seed and toss it into the air, and it will descend to the ground with a rotary motion, like that of a pickerel spoon when drawn through the water. As the seed descends, its wing by this rotary motion forms a spiral plane at an angle with the direction of its descent, serving as a parachute to sustain it in the air. If there is the slightest breeze, the seed floats off upon it and descends diagonally to the ground. The phenomenon is much the same as that observed in the fall of

seeds of the ash and some other deciduous trees. Such seeds, like the pine seed, are winged for distribution. Although they will not float on the gentle breeze like thistle or dandelion seeds, still in a strong wind they are carried quite a distance, fifteen or twenty rods, possibly farther. When the seeds fall to the ground they soon separate from their wings. A heavy rain or the foot of some animal may bury them, or falling leaves may cover them, and the planting is done. If they fall upon the surface of a lake, the gentle breeze wafts them along over the surface like a fleet of little boats to islands or distant shores; should they fall upon a stream, they float away with the current. Although the seeds of many forest trees do not grow their own wings, we find them as widely distributed as the seeds of the pine. Nuts and acorns are furnished with transportation by the wings or legs of animals that feed upon them.

Notice the distribution of the wild cherry along the roadsides. In the spring you see here and there on cherry bushes or trees the webs of the tent caterpillar. They are usually found upon the apple and wild cherry, and if you search the woods and fields, along the walls between pastures and on bushy hillsides, you may, perhaps, be surprised to find caterpillar "tents" everywhere, and usually on some species of wild cherry. The wild cherries are scattered all through the woods, where the birds, feeding upon the fruit, drop the stones as they fly. It is a rule of nature that the destroyer of the fruit is also the distributor of the seed.

The other day I noticed a young pine growing some ten feet from the ground in the fork of a maple tree by the roadside. Who planted it there? Years ago I watched the squirrels in the great forests of the Pacific slope. They worked in pairs. One squirrel, climbing the giant trees, cut off and threw down the cones, doing this so rapidly that two or three were sometimes in the air together on their way down, the last having been detached before the first reached the ground. The other squirrel, biding at the foot of the tree, carried off the cones as they fell. No doubt some of the cones were left on the ground where they fell; but most of them were carried to a distance and hidden away in the earth-mould or in the squirrels' storeroom. High in the

trees the busy, garrulous jays pottered about among the branches. Here on the Atlantic coast squirrels and jays, though of different species, have for ages buried their food in the same way.

In the autumn of 1897 the mast crop was light in some sections of eastern Massachusetts, but here and there an oak tree was found which bore a good crop. Such trees were soon discovered by the jays and squirrels, several of which might be seen gathering the acorns from each tree. The ground squirrels work in pairs, as do the squirrels of the Pacific coast, one climbing the tree and throwing down the acorns to the other.

The jays alight in the tree top, each jay breaking off an acorn with his feet, sometimes hammering it open with his beak and eating it on the spot, or carrying it off to some hiding place; sometimes dropping it from the tree or while flying, apparently for no purpose except to hear it strike the earth.

Have you ever noticed what a mania jays, crows and squirrels have for distributing and hiding things? One whose childhood has been spent in the country will recall an old shellbark hickory by the cottage door, with the crevices of its ragged bark ornamented with walnuts, tucked in here and there all over the trunk. Any one watching the jays and squirrels in the fall will find them filling crevices, dropping nuts, acorns, corn and other things into cavities and hollows in the trees, or burying them in the leaf-mould on the ground.

I once watched a crow killing a large, brightly colored beetle, probably *Calosoma scrutator*, which he carefully buried beneath a tuft of grass. Returning a few moments later he unearthed the creature, carried it away and buried it in another place. In a pine wood in Medford, on April 16, 1897, several crows flew from the ground. Here under the pines an interrupted feast was found. Crows, jays or squirrels had been digging out stores of acorns which had probably been buried there the previous fall. The interrupted diggers had left six acorns dug from one hole. Others were partly unearthed.

It is said that squirrels bite off the germ ends of the

acorns before burying them. This habit has never come under my observation. These acorns not only had their germ ends intact, but seven of them had sprouted. One had sent the tap root down four inches into the mould. They had been carefully set with the points downward, as nicely as it could have been done by a man. They were deeply covered with light mould and pine needles. Some of the digging looked like the work of squirrels, but marks on some of the acorns were apparently made by the beak of a bird. A gray squirrel was seen near by. Had his feast been interrupted by the crows or had all been at work together? How does the crow know that the acorns lie buried just there? Does he remember that he planted them? Does he find them by scent? Has he seen the disturbance of the pine needles, caused by the young sprout? Or has he watched the squirrel, and descended to rob it of its stores? Who is wise enough to interpret the workings of a crow's mind? Who can tell how far its perceptive faculties will serve, or mark the boundary between instinct and reason? You may say these creatures had been merely storing up food against a season of want, and that is true, but it is only half the truth. It is true also that many of the seeds which are hidden by the squirrels are never found by them again. There is an immense amount of vitality in these creatures, which must be expended in some way. When the red squirrel is not eating or providing food for himself, or getting into some abominable mischief, he is scolding or chattering in profane squirrel language at some intruder, or busy burying or digging something up. We know that the duck-hawk slays when it has no appetite, and leaves its victims where they fall; that the shrike impales many victims which it does not eat, thus furnishing winter food for jays and titmice. If rapacious birds slay for the joy of killing, no doubt the squirrel plants for the joy of planting. At any rate, in thus planting it fulfils one of the purposes of its existence. The squirrel makes his journeys back and forth, burying the acorns and hickory nuts in secret places. One day, however, as he is going his accustomed path up the walnut tree, a hawk swoops down and gathers the squirrel to his fathers. That squirrel has stored up for future use a

supply of food which he will never gather. As Thoreau says, he is "planting a hickory wood for all creation."

Even the wood mice are given to such tricks. While living, one winter, in the woods, four children had stored in the house several quarts of chestnuts. These chestnuts would disappear mysteriously from their receptacles, and reappear in the most unique places. If on retiring at night one left his shoes upon the floor, in the morning he would find the toes stuffed with chestnuts. They were found deposited in various hiding-places all about the house, and were moved from night to night, being carried from the ground floor to the attic and returned again. Single chestnuts, chestnuts by pairs, chestnuts by the dozen and by the score were transported and hidden in the most unlikely places throughout the building. A full quart of these chestnuts might be gathered in the morning from the various places in which they had been secreted during the night. There were no house mice or squirrels in the house, but by keeping a watch and setting a few mouse traps it was found that a small colony of deer mice had stolen the chestnuts and put them "in circulation." Here, then, we have a planter of chestnuts.

The birds and squirrels destroy a great part of the seed crop, but the trees produce a great surplus, and the wild creatures plant and leave to germinate an abundance of good seed. Thus the destroyer of the seed disseminates and perpetuates the very tree which furnishes its sustenance.

THE SUCCESSION OF FOREST TREES.

When you cut down an oak or chestnut wood, especially if it is old and heavy timber, a pine wood is likely to spring up in its place, particularly if there are pines near by; while, if you cut off a pine wood, it is usually succeeded by a wood composed mainly of deciduous trees, mostly hard woods, or the nut, cone or acorn bearing kinds. Such a succession of trees has long been considered by farmers to be the rule. In other words, in some way there comes rotation of crops when wood lots are cut off. It is believed by some to be due to the springing up of seed which has been buried for many years in the ground. When an oak

wood springs up where a pine wood has been cut away, there is no doubt that it has sprung from seed in the ground. But it has not sprung from seed which has been buried for many years, but from seed buried probably within the year by birds and squirrels, and which has been given a new lease of life by the sun's rays let in by the removal of the dense foliage from above. All through the autumn months, when nuts and acorns are plentiful, jays, crows and squirrels are gathering and storing away the seed among the pines where they resort for shelter.

Thousands of crows will roost in a pine wood for months during the winter when the leaves are off the deciduous trees. The pines then offer the best hiding-places for all woodland creatures. In some of the large crow roosts among the pines extensive deposits of various seeds and other material are found. When a pine wood is surrounded on all sides by oak and walnut trees, when squirrels, jays and crows are plentiful and the trees bear well, great quantities of acorns and nuts will be carried by these creatures into the pine wood, and buried beneath the dead "needles" or hidden away in crevices. Although these nuts and acorns are buried in the mould during the fall, many of them are dug up in the winter months, especially by the red squirrel. But many are never found.

Note an opening in the pines made by cutting away a few trees. Here young oaks spring up, and we find oaks and walnuts in such openings quite as often as we find pines. Examine the ground under the pines in the summer, and you may find many little oak, walnut and maple trees coming up from beneath the pine needles, and you will also find here and there young pines. All these young trees soon die in the dense shade of the larger pines.*

If the conditions are favorable when the pine wood is cut off, then the young, hard woods spring up and flourish. But why do not pines spring up where pines are cut off? First, pines do not sprout from the stump; next, there is not a regular crop of pine seed each year, so that when the

* If the lot is not favorably situated and if birds and squirrels are not plentiful, and, above all, if the crop of mast has been light the year before, there may be no young walnuts and oaks springing up.

pine wood is cut there may be no good seed in the ground. Again, young pines need some shade and protection, and if the larger trees are all cut down, many of the young pines may die when exposed to the sun. Those who, with a knowledge of this fact, plant pines on unshaded ground, especially in a season of drought, plant rye or some other cereal with the pines, so that the quickly growing grain may shade the young plants the first year. As we travel through the country we can usually see how the young pines are seeded down under favorable conditions. Many of the neglected pastures of the State are being clothed with pines. Note a group of large pines in a pasture. They were left, perhaps, when the woods were cut off there years ago. On the shady side of these are a few smaller trees, and beyond these others smaller still, and so on, the pines grading in size according to the distance from the parent trees, until at the limit of the plot there is an outer growth of little pines, perhaps only one, two or three years old. The seeds which blew first from the large pine and fell in its shade have germinated and flourished well, while many of those on its sunny or exposed side died. Now, let us see why pines appear where hard woods have been cut off. This kind of succession is not so common, as many of our hard-wood lots are cut for cord wood as soon as the trees are of sufficient size. Sprouts shoot up from the stumps immediately on the opening of the season, choking many young pines. Yet some will flourish, and there is then a mixed growth of pines and hard-wood trees. This is the character of much of the wooded region near Boston. But if an oak or walnut wood is allowed to grow until the trees are old, and is cut when the roots have lost their vigor, sprouts, if they come up at all, are not so vigorous, and the pines have a better opportunity. Where squirrels are numerous, a considerable part of the fruitage of the pine is removed by them and the cones are buried or scattered about, not only among the pines, but among the hard woods. Watch the squirrels for proof of this statement. The winds also scatter pine seed far and wide, among deciduous trees. So, if there are pines near hard-wood lots, there are usually young pines among the hard-wood trees. When the hard woods are cut off, these

young pines, having had a start in the shade, flourish and afford some shade for still younger seedlings, which quickly germinate from the seed scattered through the lot. In some cases the cattle turned out to browse keep down the broad-leaved species and spare the pines. Thus the pine wood succeeds the oak.

PRUNING THE TREES.

If the young tree escapes or survives the assaults of its many enemies and grows lustily and vigorously, it is prone to an over-production of fruit or leaves. Orchardists and foresters practice pruning, and believe that when it is judiciously done it is good for the tree. In this practice they are right when they follow nature, and do not attempt to "improve" too much upon her methods. Nature has many ways of pruning. Superfluous buds are nipped off by birds, or destroyed by bud worms and other insects. When the sun lies warm in February and March on wooded hillsides the partridge (*Bonasa umbellus*) may be seen "budding" on the alders and birches. Neither is it a stranger in the orchard, for it is fond of the apple buds. In May the rose-breasted grosbeak (*Habia ludoviciana*) and the purple finch (*Carpodacus purpureus*) attack both buds and blossoms, scattering snowy petals far and wide. All trees have many so-called enemies which live upon them. There are said to be over five hundred different species of insects injurious to the oak.* Still we have oaks, for most of these insects when occurring in normal numbers are beneficial rather than injurious. Their interests are identical with those of the tree which supplies them with sustenance. A few caterpillars may be a benefit by removing surplus foliage, and thus checking a too vigorous development which otherwise might be injurious. Others, if not too numerous, may benefit the tree by destroying the surplus fruit. Certain insects, as the oak pruner, cut off the twigs; others, like the imported leopard

* Packard says: "The number of determined species of oak insects recorded in the following pages is over four hundred, while the number of undetermined species would carry the number up to over five hundred, or about as many as Kaltenbach records for Germany. It is not improbable that ultimately the number of species of the United States will be between six hundred and eight hundred or even one thousand." (5th Rep. U. S. Ent. Com., 1886-90.)

moth, destroy branches. In 1896, oak pruners (*Elaphidion villosum*) were numerous in eastern Massachusetts. They attacked several species of oaks, also hickories and maples. They also attacked the apple tree. Their occurrence in numbers seems to be periodical, and thus the trees are subject to a more or less regular periodical pruning. Large quantities of twigs and small branches fell from the oaks and other trees in 1896, and it appeared as if the oak pruners might do considerable injury to these trees. But the trees are certainly not injured, and very likely in most cases they have been benefited by this removal of the twigs from the top branches. Since 1896 the oak pruners have been so well held in check by their natural enemies that they have not been conspicuous. When branches are injured by insects or over shading to such an extent that they die, they are removed (when weakened by decay) by the action of the wind, or are broken down by the collection of ice and snow upon them.

THE GUARDIANS OF THE FOREST.

If the insects and other creatures which feed upon the trees and their products were allowed by nature to increase unchecked, they would soon destroy all the forests from the face of the earth. Although when in normal numbers they may be a benefit to the trees, it is still true that, when abnormally numerous insects constitute a most serious danger to forests; therefore the creatures which feed upon insects and so hold them in check should be protected, as the guardians of the forest.

In the first warm days of early spring, when nature is roused from her winter sleep and the crude sap is coursing sluggishly through the branches, moving toward the unopened buds, slow-crawling reptiles and batrachians awaken from their winter sleep. From every pool and swamp in the forest is heard the croaking of the frogs. The little *Hyla* pipes its high treble, the flat baritone of the wood frogs swells the chorus, and from the margins of dark pools here and there the deep boom of an early bull-frog accentuates the chorus like a bass drum in an orchestra. As the buds burst and the little leaves begin to appear, the tree

frogs leave the pools and ascend the trees. The larger species scale the trunks, sitting here and there like ugly excrescences on the trees, but unobserved because of their protective coloring, and feeding on insects which they find on the trunks and branches. The little squirrel tree frogs (*Hyla squirrela*), sticking to the limbs and twigs as flies stick to a wall, leap in bird-like flight among the branches, gathering tiny insects there. The wood frogs glean from the dead leaves on the ground and from the undergrowth their share of the tree's enemies, while at the edge of the wood in the early morning light our old friend the toad sits patiently at the foot of some huge tree, snapping up unfortunate caterpillars that descend the trunk.

With the opening of the leaves the insect hordes increase. Bark lice swarm on the trunks, plant lice appear on leaf, twig and stem. As the warm days of spring revivify vegetation and the sap ascends the trunks and branches, the buds expand and open to the sunlight. The same warm sun which brings forth the leaflets stirs to life the embryos within the millions of insect eggs deposited among the trees, and even before the leaves have opened, hordes of tiny caterpillars are seeking every crevice in the buds.

A warm wind blows from the south, bringing new life to leaf and insect. Tiny perforations are now plainly seen, where each worm has gnawed bud or leaf. During the night swift wings are heard, with many a cry and chirp, as the birds come in on the warm south wind. And when the sun again appears, filling the woods with warm odors from the steaming ground, its rays light up a procession of beauty, for the migrants from the south have come. Thus come they always when the spring has prepared their food for them, and now the wood is alive with merry warblers, swinging actively from bough to bough and lightly pecking the tiny caterpillars and plant lice from their resting-places on the twigs and leaves. The birds pass on, destroying countless numbers of insects as they go, and are succeeded by other busy throngs. This goes on during the latter part of May, when, notwithstanding the inroads made in their numbers by the birds, the caterpillars have become so numerous and destructive that in some places many branches are denuded

of their foliage. But soon the young of the resident birds are hatching, and they require an enormous amount of insect food. Thrushes, sparrows, swallows, flycatchers, warblers, wrens, cuckoos, titmice, blackbirds, jays and many other birds of the forest, orchard, pasture, field and meadow all repair to the grove, where food is so plentiful and so easily obtained. Soon the destruction of the caterpillars is doubled, as the young birds, fully fledged, are led by their parents to these favorable spots. The trees in some localities have now been almost entirely denuded of their foliage, and stretch out their bare arms as if in supplication for deliverance. Their branches are festooned with the webs and threads spun by feeding worms. Many of the insects have pupated, and some have emerged from the chrysalis, but the birds are still busy among the desolated woods. Sparrows, thrushes, cuckoos, jays and crows are hopping among the branches or upon the ground, picking up, killing and devouring the caterpillars or tearing open the cocoons. Flycatchers are flitting about among the trees, catching the flying moths. Titmice are searching in the crevices for eggs. The young of the grouse, quail, towhee and thrush are fed largely upon insects on or near the ground. They destroy vast quantities of these during the summer.

Now look more closely, and you will see that injurious insects have other though smaller foes. Ichneumon flies are thrusting their sting-like ovipositors into the bodies of the caterpillars. Beetles of the genus *Calosoma* are climbing the trees in search of caterpillars, others of the genus *Harpalus* are destroying caterpillars and pupæ on the ground. Strange bugs are piercing them with trenchant proboscis. At night, mice and squirrels, whip-poor-wills and bats come to the feast, while the quavering note of the screech-owl is heard intermittently between his lepidopteran meals. As summer grows into fall, the warblers sweep through the woods, bringing with them their young, and taking toll, as they go, from the insect pests. In the season of the falling leaves, the sparrows, thrushes, crows and jays are busy destroying many of the tree enemies that have been left by the summer visitors. As the leaves fall and the snow comes, the woods appear almost deserted; but here and there a

party of titmice will be found, and a few woodpeckers, nut-hatches, kinglets and jays remain about the woods all winter. These birds, feeding largely upon the hibernating insects and their eggs, deposited on the bark or in its crevices, are enabled during the winter months to destroy far more insects, either dormant or in embryo, than the same number of birds can dispose of in summer.

When the snow comes, the hares and mice, driven by hunger, gnaw the bark of the young trees. As these animals are very prolific, they would cause great havoc in the woods, especially among the younger trees, were it not for the solemn owl, who sits alone, and from his watch-tower in some old pine looks down more in sorrow than in anger, and gathers them into his larder. It is remarkable how many hares, mice and other small animals a large owl will destroy in winter. The owls are also liberal providers for their young. I once found in the nest of a great horned owl (*Bubo Virginianus*) two young owls less than three days old, and lying beside them, and partially covering them with the fur, were the hind quarters of a hare. In the nest of a barred owl (*Syrnium nebulosum*) in Woburn there was found the greater part of a hare and several other small animals, which apparently had been provided as food for two very young owls. Owls as a class are among the most useful birds. They destroy great quantities of insects, as well as numbers of field mice, but comparatively few birds and poultry. The fox is another great destroyer of mice and hares, and is not therefore by any means an unmixed evil.

Let us go now to the western forests, where man has not yet disturbed nature, and observe the sequence of nature's forestry. In this untrodden wilderness, trees which have outlived their usefulness and have become weakened by old age must come down to make room for those younger and more vigorous. Their forms must then be reduced to dust, to supply the new growth with nourishment. Dust unto dust, — it is the law. In a forest of firs, pines and cedars on the Pacific slope the trees have nearly terminated the allotted period of their existence. Some of them have already fallen, letting in light and air among the young

trees which are springing up to take their place. An army of insects attacks the remaining trees, defoliating them and letting in the light and heat of the burning summer sun. This still further stimulates the growth of the young trees, which are coming up partly shaded by the trunks and limbs of the forest giants; but its fierce rays only serve to weaken the old trees, as they stand naked under the cloudless sky. The sap pauses in its flow, and they are now in a condition to invite attacks from the bark beetles (*Scolytidæ*). A host of these appear, boring into the inner bark, where they cut their channels through the liber and cambium and along the surface of the wood beneath. The diseased trees are now doomed. Helpless, they are attacked by a host of borers and other wood-eating insects. Death from a thousand wounds ensues. The insects channel, cut and powder the substance of the trees, wood-rot attacks the trunks, limbs fall and tops crash down. Some night a great wind comes down through a mountain gap and rushes through the forest. Giant trunks are uprooted and thrown against others still standing, shattering all. Great trees tottering to their fall crash against others already fallen. Bending with mighty groan they break short off or are uprooted with a fearful crash, and their tops sweep through the air with a moaning shriek, which is lost in the thunder of their fall. Down they go like a row of blocks before the awful wind. Their downfall shakes the earth, the fowls of the air hide their heads in fright, the beasts of the forest crouch closer in their dens or slink away in terror. When morning comes the old forest is no more, but in its place a tangled windfall lies, where one can walk for miles on fallen trunks without touching foot to the ground. Amid this mass of trunks the bear will find his den. Here he will tear away the decaying bark with his claws to get at the ants burrowing beneath. Here the swilal berries and the salmon berries will grow and the skunk cabbage will flourish in the swales. Here is good food for the bear. The bear is not only a forest planter but also an agent of destruction to the ruined forest and a cultivator of the soil for the new growth. In this work the wild hog, fox, marmot, elk and other animals have a share. Here also is the home of the woodpeckers, for they have now a

mission to perform. They must do their part in preventing too great an increase of the wood-eating beetles, and so protect the young pines springing up among the ruins where the forest that is to be is rising from the bones of its progenitors.

Years roll away, and a new forest waves its branches where the old trees once stood. All that remains of the old now is a great trunk, forming a natural bridge across the stream. Huge and moss-covered it lies, a relic of the past. Along its upper surface runs a well-beaten path, traversed by the shuffling bear, the slinking wolf or the timid deer, descendants, it may be, of the animals who were sheltered by its branches in their prime.

But, you say, what is the practical bearing of all the foregoing? What the utility of the observations made? Know, then, that we cannot study the relations of the creature to its environment without learning something of the great plan governing all. We cannot enter upon the consideration of any of the forces which regulate the increase of animal or vegetable life without being brought face to face with the great laws by which the balance of nature is preserved. How beautiful and yet how complex is this great plan, by which each species of plant or animal fits into the proper place just so long as it serves a useful purpose, then filling a subordinate place, and becoming extinct when its mission on this earth is ended.

Were there no law regulating the increase of the pine, it would be but a few centuries ere the whole earth would be covered with pines. In such a case there could, of course, be no wood-eating borers and no birds to feed upon such insects; there could be no grass-eating animals, for there would be no grass. Man himself could not exist.

Wood-eating insects are no doubt a necessity and are useful, when properly held in check by the birds which feed on those insects. If a single species of insect were allowed to go unchecked, it would be but a few years before all the foliage upon the continent would be destroyed. Kirkland has figured that the unchecked increase of the gypsy moth (*Porthetria dispar*) would in eight years destroy all foliage in the United States. It is easily demonstrable that certain

other species of insects, if unrestricted, could cause similar devastation. When such insects have spread over the continent, such an increase and such a devastation can only be prevented by the natural enemies of those insects; and here comes a practical lesson. Man should not disturb the balance of nature. But what does man do to preserve this balance of nature? Generally, nothing. What does he not do to disturb it? Man enters a new country, destroys the forest (and with it the forest animals), plants new crops, thus inviting new insect pests, and at the same time exterminates the birds and animals which feed upon those pests. He destroys the blackbirds of the west, because they feed upon the corn; the grouse, plover and quail he sends to market for profit, doing his best to exterminate them all. Soon the chinch-bug runs riot, cut worms destroy his corn, migrating locusts sweep away his crops and gaunt famine stalks in their path.

The Siberians kill the birds for the milliners. Soon cut worms, locusts and other noxious insects destroy the crops and nearly starve the inhabitants. Thus both bird and peasant suffer on the altar of fashion. Even the Siberians can learn by experience, and laws with heavy penalties are passed and enforced to protect the birds.

Man attempts to improve upon nature. He introduces new forces for a purpose. A water plant is imported into the southern States from South America. It chokes up the rivers, and navigation is suspended. A snake-eating mammal is introduced from India to an island in the Caribbean. Its predaceous habits become the indirect cause of such an increase of insects as to render the island almost uninhabitable. The farmers of Australia first destroy the game and then introduce the English rabbit. Great stretches of country are soon a barren waste, given up to the rabbits. Australia also imports a sparrow, which soon destroys the grain crops. Unheeding this sad experience, we introduce into the United States the same sparrow to feed upon the span worms in our parks. It destroys the span worm, but drives away our native birds, and our parks are soon infested with a host of caterpillars. It also destroys our grain and fruit.

Verily, as Wilson Flagg says, "man is only a half reasoning animal; the blood of the ape still courses through his veins."

Other introductions of insects and plants occur. The Russian thistle is imported, and sweeps over our western prairies, adding to the farmer's "crown of thorns." Introduced grain insects destroy the crops. Moths and scales carelessly imported injure and destroy the trees.

Let man, then, study the natural conditions of field and forest, abandon all attempts to improve upon nature by introducing new forms of animal or vegetable life, and devote his misplaced energies to protecting those native birds and animals which are the naturally constituted guardians of vegetation. This is the first great lesson to learn from nature's forestry.

Now for minor details. From nature's planting we may learn the depth to which the seed should be buried, and that, when a wood lot is cut off, some trees should be left to shade the young plants. We may learn that young oaks grow best on pine ground and when shaded by a few pines; that timber trees grow best and straightest when they are planted thickly, so that the tops, continually reaching for the light, build up a tall, straight trunk. We may observe how the lower limbs of the pine die and fall off, so that the wood-rings of later years will form clear timber, free from knots. We may anticipate nature's pruning here by trimming off the lower branches of young pines, continuing this process year by year as the trunk grows upward, so that in thirty or forty years we may grow from the seed good, clear white pine timber, free from black knots. We can remove sprout growth, leaving seedling trees, getting cord wood first and good timber later. We can anticipate nature again by cutting the weaker trees ere they begin to decay, and by rational forest management we can secure an annual product from the wood without sacrificing it as a whole. We can protect the birds who, living in the woods, will help to keep down the insects, not only there but in the near-by field, orchard or garden.

Meanwhile, study nature's methods. Her book is always open, and "he who runs may read."

THE SAN JOSÉ SCALE IN MASSACHUSETTS.

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The presence of the San José scale in Massachusetts was first recorded by Prof. C. H. Fernald, entomologist to the Board, in the Massachusetts Crop Report for August, 1895. The insect had then been found colonized in five localities in the State. At the present writing thirteen localities are known to be infested, and from the recent rapid increase of the known occurrences of the insect it is evident that we are just beginning to realize the extent to which this pest has been disseminated throughout the Commonwealth. During the past three years the writer has had opportunities to become familiar with several colonies of the scale in eastern Massachusetts, and, at the request of Secretary Wm. R. Sessions, has attempted to combine the notes thus made, supplementing them with extracts from the writings of others, particularly in those portions relating to the life history of the insect and remedies available for treating infested trees. It should be stated at the outset that the study of this important insect has received the attention of our leading economic entomologists; and, as a result of the careful work of Messrs. Howard, Marlatt, Smith, Webster and others, we may now easily obtain an accurate knowledge of the history and habits of the insect, its means and routes of distribution and the remedies best adapted to destroy it. Entomologists are especially indebted to Dr. Howard and his assistants for the exact information concerning the life history of the scale, as published in Bulletin 3, New Series, Division of Entomology, 1896, a work that has been the basis of the majority of the treatises on the subject appearing since that date.

DISTRIBUTION.

The original home of the San José scale is yet a matter of conjecture. It is known to occur in Chili, Hawaii, Australia and the United States, while two varieties of the species have been found upon trees coming from Japan. The occurrences of the scale in Chili and Hawaii have been practically traced to the United States; the Australian infestation is thought to have been brought from Japan; and Professor Cockerell, our leading authority on this group of insects, is quite certain that the latter country will ultimately prove to be the original home of the pest.

In the vicinity of San José, California, from which place the insect takes its common name, the scale was quite injurious as early as 1873; and, when described by Professor Comstock in 1880 as "the most pernicious scale known in the country," it had become destructively abundant throughout a considerable part of the fruit-growing region of that State. Since the insect primarily appeared as a pest to fruit trees, its dissemination upon nursery stock soon followed. According to the statement of a member of the firm of Stark Brothers at the Indianapolis meeting of the American Association of Nurserymen in 1895, the first consignment of infested trees to reach the eastern United States was shipped in the spring of 1887 from a Californian firm to the Parry and Lovett nurseries of New Jersey, the firm of Stark Brothers acting in this case as transmitting agents. From these New Jersey nurseries as starting points, many of our eastern nurseries became infested, thus increasing the number of centres of distribution. Many orchards throughout the country also became infested with the scale as a result of the direct purchase of stock from these nurseries.

While it is generally conceded that 1887 marks the date of the first importation of the scale to the east, a case has recently come to the writer's attention that would indicate the possibility of the occurrence of the San José scale in a Long Island nursery at a date somewhat earlier than that of the New Jersey infestation, and possibly as a result of the direct importation of trees from Japan. The facts are these: —

In the vicinity of Boston there is an educational institution where particular attention is given to the study of trees and shrubs. On the grounds of this institution there is a colony of the San José scale which is confined in great measure to a plot of perhaps thirty Japanese quince bushes. These bushes, according to the testimony of those in charge of the grounds, "have been infested for many years." Careful records of all trees planted are kept by the authorities of the institution, and in this case the records show that the bushes in question were purchased from three sources: the firm of James Veitch & Sons, London, England, in 1881; Louis Späth, Rixdorf, Berlin, Germany, in 1888; and the Parsons & Sons Company, Flushing, Long Island, in 1884. The greater part of the bushes was obtained from the latter source, and these are infested to the greatest extent, although the scale occurs on all of them. The infestation of this nursery for many years past is a matter of common knowledge among entomologists and nurserymen; also the fact that this nursery has paid especial attention to the importation and distribution of Japanese stock. Unfortunately, all of these Japanese quinces were grown for one season in a very compact plot, and their infestation is so general that it is impossible to decide which were the ones originally infested. From an inspection of the grounds it is evident that these bushes are the centre of infestation in this colony; and, unless it is shown that the English and German nurseries are infested, of which there is no evidence at present, the natural inference is that the Long Island nursery is the source from which the infested stock was obtained, thus antedating the New Jersey occurrence by about three years. Against the conclusion that the Long Island stock was the source of the scale at this particular locality may be placed the length of time elapsing since its purchase, — some fourteen years. The time required for the killing of trees by the scale is placed by Messrs. Howard and Marlatt at from two to three years. In the south, where the active season of the insect is longer than it is here, and the warmer climate more favorable to its multiplication, undoubtedly this may be the case. It is also probable that a longer time is required for the destruction of trees from this cause in this region; for we have

records of an apple orchard at Scituate, Mass., planted in 1892 with infested trees two or three years old, of which

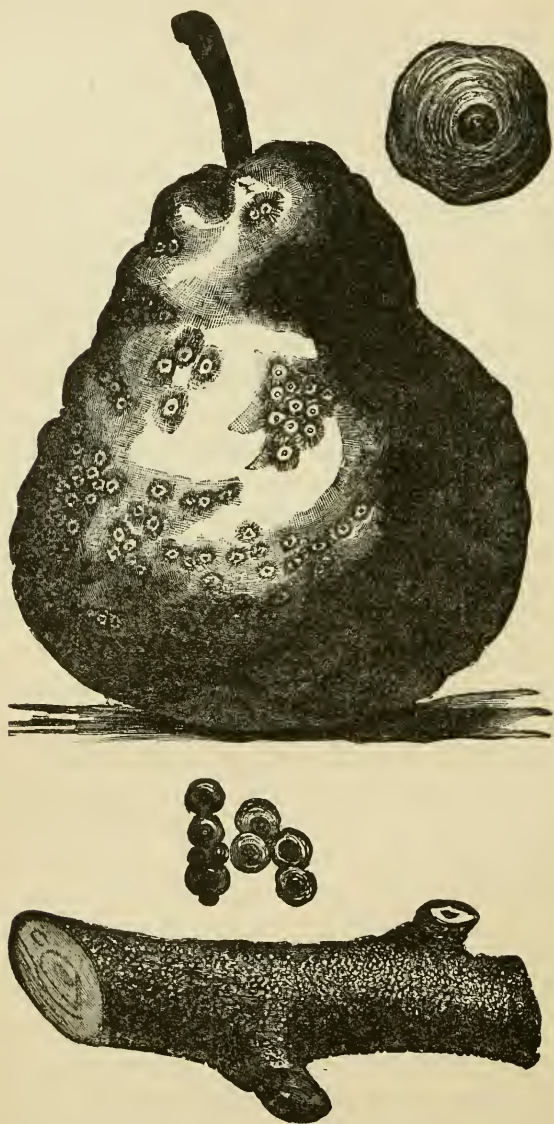


FIG. 1. Pear infested with San José scale (*Aspidiotus perniciosus*), and enlarged female; infested twig, and enlarged males. From Howard, Year Book, U. S. Department of Agriculture, 1894.

about ninety per cent although very badly affected, were alive in 1897, at which time remedial measures were applied.

Since a Japanese quince with vigorous roots will throw out an abundance of new shoots year after year as the old wood dies off, the continued infestation since 1884 of the bushes previously mentioned does not seem beyond the limits of possibility.

In a recent bulletin Dr. Howard gives the present distribution of the San José scale in the United States as follows:—

Alabama, Arkansas, Arizona, California, Connecticut, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, West Virginia. It has been found also in British Columbia and Ontario, Canada.

In the same bulletin Dr. Howard gives a list of the infested localities in Massachusetts as furnished him by Professor Fernald. It includes: Amherst, Bedford, Brookline, Cambridge, Jamaica Plain, Reading, Roslindale, Scituate, South Chelmsford, South Framingham, Worcester. To the above list Professor Fernald now adds Auburndale and Belchertown, while the writer has recently discovered a limited occurrence of the scale in Malden.

As is well known the principal method by which this insect has been disseminated throughout the country is through the sale of infested nursery stock. Without doubt local distribution is facilitated by birds and insects. The young lice, although minute, are active, and, readily crawling upon the feet of birds or the bodies of insects, may be transported to a considerable distance. In an infested orchard large numbers of the scale usually will be found under and around birds' nests; and, when examining trees for the scale, those in which birds' nests are located should receive the most critical attention.

DESCRIPTION OF THE INSECT.

When the San José scale is abundant, its presence is soon betrayed by its effect upon the trees. Infested trees are usually stunted, do not put forth vigorous foliage and make but little growth. An examination of such sickly trees

frequently results in the discovery of multitudes of the minute, dark-gray, circular or slightly oval scales massed on the trunk and older branches, while the younger growth is thickly dotted with single scales. The scales are often so numerous on the trunk as to make a thick, scurfy crust, that may be removed in a layer. While most commonly found on the bark, they also occur on the fruit and leaves. The writer has found this insect abundant on the fruit of the Japanese quince, and in a single orchard on apples and pears. When the scales occur on the fruit or young growth, they are often bordered with a purplish margin of discolored tissue. On the bark beneath the scales a similar coloring is found; but this peculiarity is not confined to the San José scale, since the scurfy bark louse sometimes produces the same effect. This discoloration of the bark, however, is of considerable assistance in the recognition of the San José scale in the field.

The nearly mature insects winter over beneath their scales, and complete their growth early in the spring. During a period of about six weeks the females give birth to several hundred young, and at the end of this time the first-born insects are mature. The young larvæ, after escaping from beneath the female scales, appear as a fine, yellowish dust on the bark, and swarm over the tree in search of a suitable settling place. Having become fixed, they insert their beak into the bark, secrete a scale, and soon become like their parents in appearance and capacity for damage. The active season of the insect is doubtless shorter in Massachusetts than it is farther south. Accurate information on this point is lacking. On May 21, 1898, I found young larvæ abundant on a badly infested, purple-leafed prune at Cambridge, Mass.; while at Auburndale, Mass., Oct. 9, 1897, a few days after a light frost, infested peach trees were swarming with the young lice. This shows us that here the insect multiplies throughout a season of over four months.

By isolating female scales on small trees, Messrs. Howard and Marlatt found the number of young borne by a single female to vary from thirteen to five hundred and eighty-seven; and, assuming four hundred young to be a fair

average, these gentlemen find that in the course of a single summer one female might become the parent of over three billion progeny. When one contemplates the remarkable rapidity with which this insect multiplies, — a brood of about four hundred every six weeks, — what wonder is it that in the space of two or three seasons this prolific pest is able to spread over even large fruit trees? The lapping over of the different generations is one of the greatest hindrances to the successful use of insecticides against this insect. With many of our scale insects the young appear at known intervals of time, and the use of a suitable contact insecticide at the proper time will insure the destruction of the whole

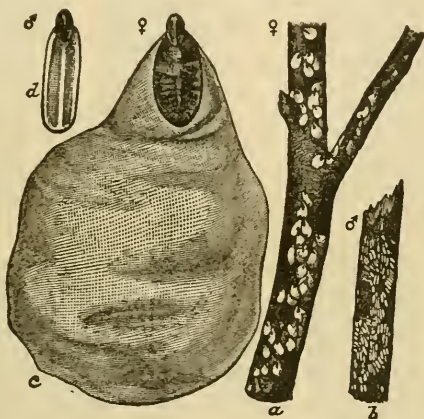


FIG. 2. Scurfy bark louse (*Chionaspis furfurus*): *a*, *c*, females; *b*, *d*, males; *a*, *b*, natural size; *c*, *d*, enlarged. From Howard, Year Book, U. S. Department of Agriculture, 1894.

brood. Not so with the San José scale. Such a wash, to be effective, would need to be repeated daily for perhaps six weeks in order to destroy the young born at different intervals.

The two scales most commonly met with in the orchards and nurseries of the State are the scurfy bark louse and the oyster-shell bark louse, and these two insects are the ones most frequently mistaken for the San José scale. The figures given so well illustrate the characteristics of these scales that detailed description is unnecessary. The scurfy bark louse (Fig. 2) is common on trees of the apple family and on currant bushes. It is compact, slightly elongate, thin, and

usually of a light, dirty-gray color. The oyster-shell bark louse (Fig. 3) also occurs on the apple, pear, etc., and on ash, willow and poplar as well. This insect differs from the preceding species in that the scale is more elongate, and usually curved. The molted skin of each insect forms a protuberance at its apex. In Massachusetts these two insects are seldom dangerously injurious, and when overabundant may be destroyed by the application of simple remedies.

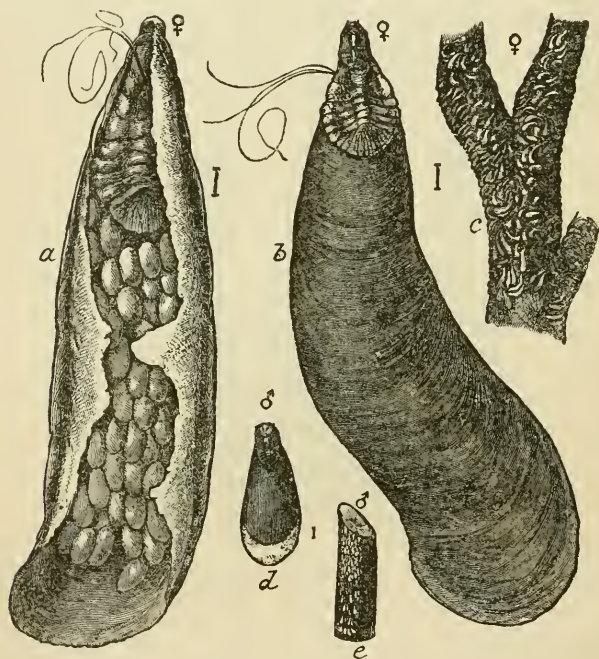


FIG. 3. Oyster-shell bark louse (*Mytilaspis pomorum*): *a*, female scale from below, showing eggs; *b*, female scale from above, both figures greatly enlarged; *c*, female scale; *d*, male scale, enlarged; *e*, male scales on twig, natural size. From Howard, Year Book, U. S. Department of Agriculture, 1894.

The San José scale (Fig. 1) is distinguished from the preceding insects by its nearly circular outline, its dark-gray color and the nipple-like projection at its centre, as shown in the illustration. The male scales are more numerous and are smaller and darker than the female scales, bearing a distinct white dot in the centre of the protuberance. The farmer should be able to distinguish between these three scales without the aid of a lens. Unfortunately there are a

few species of circular scales closely resembling the San José scale, for whose separation the use of a compound microscope is a necessity. The safest course for the farmer who finds suspicious-appearing scales on his trees is to send a piece of the infested bark or twig direct to the Experiment Station at Amherst, where experts will gladly make a careful examination of the material, and inform the sender of the nature of the insect. Suggestions concerning remedies, where the latter are deemed necessary, will also be furnished.

FOOD PLANTS.

The San José scale flourishes on a wide range of food plants, and in this fact we see another reason to fear the spread of the pest. Where infested nurseries are located near woodlands, it is highly probable that the latter will eventually become infested, and the eradication of the insect in such a locality would be almost an impossibility. In this State the San José scale has been found on the pear, apple, *Pyrus nigra*, *Pyrus heterophylla*, plum, cherry, peach, apricot, nectarine, purple-leafed prune, quince, Japanese quince, rose, currant, grape, American elm, European elm, balm of Gilead, willow and catalpa. Elsewhere it is known to attack spirea, maple, walnut, birch, etc. Dr. Howard's latest list of the food plants of this insect includes fifty-five species. From this list it is evident that the insect is capable of adapting itself to nearly all of our deciduous trees.

NATURAL ENEMIES.

Several parasites of microscopic proportions have been reared from the San José scale in the south and west, but, so far as the writer has been able to learn, none have been recorded from this State. Professor Rolfs of the Florida Experiment Station has given much attention to a fungous disease that has appeared in the colonies of the scale in the south, and finds that it is of considerable assistance in checking the increase of the insect. Samples of the fungus sent to Dr. J. B. Smith, New Brunswick, N. J., were transplanted on infested trees with only slight success. In Massachusetts the only natural enemies recorded are two species of lady-birds, found by the writer at Auburndale, Mass.,

Oct. 9, 1897. On a single badly infested peach tree there were two representatives of one species* and eight of another,† all feeding on the young scales.

REMEDIES.

The degree of the infestation and the location and age of the infested stock are among the chief considerations affecting the nature of the remedies to be used. Aside from the matter of fumigation, which will be detailed later, the same remedies are equally applicable to the orchard and the nursery.

1. *Burning*.—In treating orchard or nursery stock infested with the San José scale, the destruction of the trees, root and branch, by fire, will in the end yield the most satisfactory results. Financial or sentimental considerations may sometimes induce the owner to employ less heroic measures, and remedies for use in such cases are described later. In preparing the trees for burning, it is necessary to dig rather than cut them. This is essential because the scales frequently mass on the bark below the surface of the ground, and, sheltered in the cavity made by the swaying trunk, multiply undisturbed. Professor Webster has noticed that shoots sprouting from such stumps are usually infested, thus showing the necessity of destroying the stumps as well as the trunk and branches. As a measure of safety, it is necessary to burn not only the infested trees but also those adjacent. Where infested stock has been grown for a season or more in proximity to other trees it will almost invariably be found that the insect has spread to some distance beyond its original confines. Aside from the greater degree of safety secured, the destruction of suspicious stock will save the time and labor that must otherwise be spent in watching for the development of the scale on these trees, and in combating it should it appear. In all cases where the infestation is of recent date and limited in extent, the use of fire is the only measure that should be adopted.

2. *Whale-oil Soap*.—The value of this substance as a remedy for the San José scale was brought to public atten-

* *Adalia bipunctata*.

† *Chilocorus bivulnerus*.

tion in 1896 by Messrs. Howard and Marlatt, and thus far has given uniformly satisfactory results as a palliative measure. It is applied at the rate of two pounds to one gallon of water as a winter wash only. The soap is cut into small pieces, dissolved in hot water, and, while warm, applied in a spray to the infested trees, or the trunks and branches may be first scrubbed and later sprayed. A boiler or kettle holding from five to fifteen gallons is a necessity for work in the field. Small trees need but little preparation for the treatment, but large trees should be well trimmed and cut back before spraying. A single winter washing of the trees, as outlined above, will destroy nearly all of the scales. It is safer, however, to follow the first treatment with a second at an interval of a month or more. These applications may be made at any time between November 1 and April 1.

Much has been claimed for the whale-oil soap treatment and up to the present season the writer was of the opinion that in this remedy we had a measure that was nearly if not quite exterminative in its effects. A few tests of the remedy are cited below :—

An apple orchard located in the town of Scituate was visited on March 2, 1897, and was found to be badly infested with the scale. The trees were planted in 1892, and at the time of the writer's visit three or four were dead, twelve were so badly infested that they were ordered burned, and fifty-nine out of a total of one hundred and six were generally infested with the scale. The orchard being somewhat isolated and the owner unwilling to burn all the trees, the whale-oil soap treatment was recommended, and was applied a few days later. A careful examination of the orchard Aug. 27, 1897, showed only about half a dozen living scales. Another examination on June 11, 1898, showed many scales on last year's growth, although nearly all of those examined were dead, a result of another treatment with the soap solution during the past spring. The trees are thrifty and are making good growth, yet it is evident that the scale is still present, and that remedial treatment must be kept up for some time.

In the spring of 1897 the writer personally treated a block of young infested pear trees with whale-oil soap and water

at the rate of two pounds to one gallon. June 7, 1897, no scales could be found on the trees, which during the fall of 1897 were dug and "heeled in," preparatory to shipment. An examination of these trees Dec. 13, 1897, showed them to be generally infested with the scale. In this case, sources of infestation were found later near by, yet other stock growing between the pears and the infested spots was apparently free from the scale. I am forced to conclude that a few scales survived the treatment, and by fall their progeny had multiplied sufficiently to reinfest the trees.

At Auburndale, Mass., a number of badly infested currant bushes were thoroughly drenched with the soap solution on Oct. 9, 1897. At that time the bushes appeared to be nearly dead. When last examined, June 11, 1898, they had made a vigorous growth and were in a remarkably thrifty condition. At the same time a few living scales and a few young larvæ were found, showing that the treatment, while reducing the numbers of the scale to a minimum, had not entirely exterminated the insect.

A proper interpretation of the above-described experiences is that in whale-oil soap applied as directed we have a valuable means for checking the increase of the scale, and by its use infested trees may be restored to a thrifty condition. This remedy cannot be depended upon to exterminate the insect; and, in view of the cost of annual treatments, the question to be considered is, Will it not be cheaper in the end to burn the infested stock and start anew with trees free from the scale?

3. *Kerosene*. — Recently, through the efforts of Professor Webster and Dr. J. B. Smith, the value of pure kerosene as a remedy for this insect has been extensively tested. The results thus far obtained, while uneven, have been on the whole satisfactory, and Dr. Smith has even advised owners of infested trees to use kerosene in preference to other remedies. He advises that during the month of September the oil be applied as a very fine spray, and that only an amount sufficient to moisten the surface be used. The trees must be perfectly dry, and the time for treatment the middle of a warm, sunny day. When used as above directed, kerosene has been found to kill all of the scales, usually without in-

jury to the trees except in the case of the peach and plum. In some cases, however, other species of trees have been destroyed, and at the present writing farmers are not advised to make a general use of this remedy until they have first tested it experimentally.

4. *Fumigation*. — This method is particularly valuable to the nurseryman. The trees to be treated are loosely packed in a tight room, and exposed to the fumes of hydrocyanic acid gas for a period of forty-five to sixty minutes. This gas is liberated by the action of acid on cyanide of potash in water. The necessary quantities of the ingredients for one hundred and fifty cubic feet of space are: cyanide potash (ninety-eight per cent), one ounce; sulphuric acid, one ounce; water, three ounces. The cubic contents of the fumigation house is computed, and the necessary amounts of chemicals prepared. The water and cyanide are placed in a suitable earthen dish such as a bean-crock or other wide-mouthed receptacle, and when all is ready the acid is poured into the mixture and the doors closed for the time indicated. Before removing the trees the chamber must be allowed to ventilate, since the gas is fatal to human as well as insect life.

A simple yet effective fumigation house built by one of our nurserymen consists of a double-boarded building, ten feet wide and thirty feet long. In this building there is a chamber ten by twenty feet for the fumigation of large quantities of stock or of tall trees, while two smaller chambers, five by ten feet, afford means for fumigating shrubs and small trees. After the fumigation house has been erected, the labor in handling the stock is the chief item of expense. Cyanide of potash costs thirty-eight cents per pound in quantity, and sulphuric acid less than two cents per pound. Professors Alwood of Virginia and Johnson of Maryland have had extensive experience in fumigating nursery stock, and both find that when properly conducted the fumigation treatment is an exterminative measure. From the testimony of many experts it is evident that in fumigation we have the best-known means of insuring the freedom of nursery stock from the scale.

THE NURSERY QUESTION.

Of all problems connected with the occurrence of the San José scale in Massachusetts, the nursery question is the most difficult. The public in general and farmers in particular feel themselves entitled to the knowledge in the possession of official entomologists concerning the condition of various Massachusetts nurseries. They argue, and with much force, that as servants of the public these experts should protect people from purchasing infested stock by definitely stating what nurseries are or have been infested with the San José scale. On the other hand, it would appear only just to respect certain rights of the nurserymen. No nurseryman has purposely infested his nursery with the scale. It is in every instance an accident, a calamity. This being the case, nurserymen feel that their misfortunes should not be increased by publicity, so long as they are properly discharging their obligations to the public. In fact, some of our nurserymen contend, judging from the experience of their fellows in other States, that the announcement that their nurseries had been infested with the scale might ultimately ruin their entire business.

Desiring to deal fairly with the farmer and nurseryman alike, the writer has come to the conclusion that no public good will result from the specific mention of the occurrences of the scale in the State, except in cases where there has been either an obvious attempt to defraud the public or gross negligence exhibited in producing and sending out infested stock. In cases of the latter class, it would seem to be plainly the entomologist's duty to aid so far as possible in checking the spread of this most pernicious pest.

Nurserymen may be separated into two classes,—the reputable and the disreputable. The one endeavors to maintain a high standard for his stock, and grows and sells only first-class trees. The other may disregard all obligations of common honesty, and sell stock, regardless of its condition, to all who will buy. Reputable nurserymen, finding their places infested with the scale, endeavor in all ways to eradicate it. Those of the other class throw their infested stock upon the market, with the result that hundreds of innocent

purchasers are victimized, and the pest becomes established in hundreds of new localities. To the credit of this State let it be said that the Massachusetts nurserymen who have been called upon to combat the scale as a rule have shown that they fully appreciate the importance of dealing with it promptly and thoroughly.

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LEGISLATION.

The occurrence of the San José scale in a nursery or orchard is a constant menace to the fruit and shade trees in the vicinity, and when neglected should be classed as a public nuisance. Being a nuisance, it becomes a proper subject for legislation. Lacking national laws on the subject, many States have enacted statutes whereby the treatment of infested trees is made mandatory upon the owner, and the sale of infested stock a criminal offence, punishable by fine. In some States nursery stock coming from another State will not be admitted unless accompanied by a certificate of freedom from dangerously injurious insects and diseases, issued by the entomologist of the State from which shipment was made. Germany has gone a step farther than this, and, by the edict of Feb. 5, 1898, prohibited the importation of American nursery stock or fruit.

So far as the nursery question in this State is concerned, Professor Fernald has steadily held to the idea that the laws of trade are more potent than those framed by legislators; that the man who deliberately sells infested trees, will eventually lose his reputation and patronage, while the reputable dealer will ultimately be well repaid for all sacrifices made to maintain the high standard of his stock. The soundness of this view of the case has been demonstrated by the action of the nurserymen of this State who voluntarily have gone to the expense of having their nurseries examined by experts, have destroyed thousands of trees, and have erected fumigation houses for the treatment of all stock bought or sold. This they have done not through fear of punishment, but in order to protect themselves and customers, and to retain public confidence in the character of their stock. With nurserymen so wide awake to their own

interests, it would seem that legislation to compel them to clear their places from the scale, should any occur, would be unnecessary.

There is, however, another side to the case. Several years may be required to teach an unscrupulous dealer the old lesson of the value of honesty in business dealings, and in the mean time he may have been sending the scale broadcast throughout the State, working incalculable injury to hundreds of orchardists and property owners. Again, there may be nurserymen with no reputation to lose, who depend for their income upon sales to tree peddlers and to new customers, and who will not hesitate to unload in the market any infested stock they may possess. In either case, a law to provide means for the detection and punishment of such offences would work a benefit alike to the public and reputable nurserymen. Another contingency should also be considered. A careless or malicious property owner might allow badly infested trees to stand on an estate adjoining a nursery or an orchard. No matter how carefully and thoroughly the nurseryman or orchardist might labor to maintain the freedom of his trees from the scale, such a result would be almost an impossibility until the original source of infestation had been stamped out.

The issuing of certificates to nurserymen whose stock is found to be free from the scale as yet has not been authorized by law in this State. Since nurserymen are the ones who will benefit most by legislation against the San José scale, the matter of securing such legislation is one in which they may properly take the initiative.

SUGGESTIONS TO NURSERYMEN.

In order to hold the trade of his patrons, a nurseryman must list a wide range of trees and shrubs, many of which cannot be grown in his locality, and for which he must depend upon other dealers. Remarkable as it may seem to those not familiar with the facts, our Massachusetts nurserymen are unable to raise apple trees in competition with those grown in New York, Ohio, Pennsylvania and other States, where climatic and soil conditions are more favorable to the rapid growth of the young trees. Yet in the matter of ever-

greens and many other shade trees our nurserymen supply the needs of others less favorably situated. Thus each nurseryman is largely dependent upon his fellow tradesmen for a considerable part of his stock; and, this being the case, infested trees are often unwittingly disseminated, since it is impossible, in the rush of the shipping season, to open and carefully examine all the stock received before using it in filling orders. There are, however, certain precautions which all nurserymen may adopt, and thus reduce the chance of receiving and disseminating infested stock. Among them are:—

1. *Dealing with Reputable Firms.*—There are certain nursery companies whose dishonesty in sending out stock falsely named or badly infested with the scale has made them notorious. Their disreputable business proceedings are matters of common comment among nurserymen with whom I have conversed, and yet I have frequently found that many of our Massachusetts growers have purchased stock from these firms within recent years. For example, a certain New Jersey firm for a long time has been recognized as one of the chief offenders in sending out infested trees, yet many of our nurserymen annually risk the safety of their nurseries by trading with this firm. The stigma of selling infested stock comes upon the one who makes the final sale, and in dealing with disreputable firms the nurseryman takes the chance of being classed with them.

2. *The “Refuse” Garden.*—In some of the nurseries which the writer has visited he has found a certain area of land set apart and dedicated to the use of refuse stock. Here are assembled the pariahs of the nursery world. Here dwarfed, misshapen and diseased trees are set out to live or die, as the case may be. Here all kinds of nursery pests flourish unrestricted, and from such a centre they spread out and infest the nursery. Here, also, tree peddlers and bargain hunters find and obtain their *bargains* in trees. In one case coming under the writer’s personal observation such a refuse garden contained the “culls” and outcasts of three abandoned nurseries, as well as the refuse stock of four or five years’ accumulation from a large active nursery. Out of about a thousand trees, over one-half were badly infested

with the San José scale. Such a pest spot in a nursery is a menace to all stock standing on the grounds. To the owner it also offers a temptation to sell inferior trees. The oldest nurseryman in Massachusetts in conversation on this point once told the writer that in his experience, extending over nearly fifty years, he had found it "the best policy to destroy at once all trees found to be sickly or diseased." In view of the frequent occurrence of the San José scale on such stock, the wisdom of this policy is evident.

3. *The Annual Inspection.* — The San José scale is most difficult of detection when present in small numbers. When it is abundant in a nursery or in an orchard, the limits of the infestation are equally difficult of definition. This work is one that calls for the services of the entomologist, and the careful inspection of the trees by such an expert should give the grower a fairly accurate idea of the condition of the stock as regards the San José scale. Too much should not be expected from the entomologist, since no one can positively declare a nursery to be free from this insect. When we consider that several scales might be concealed beneath a single bud, the difficulty in making such a positive statement is evident. The entomologist, however should be able to detect any well-defined infestation, and, by advising the use of proper remedies, aid the owner in stamping out incipient colonies of the insect. This examination can be made to the best advantage during the season when the trees are bare. The trees may be examined either before or after "heeling in."

4. *Fumigation.* — This has been described under the head of remedies. At the present time we believe thorough fumigation to be the great safeguard against the introduction and dissemination of the scale. Experiments by Professors Alwood and Johnson, as well as by Dr. Howard and others, have shown the possibility of destroying the scale by treatment with hydrocyanic acid gas. The cost of this treatment is but a small premium to pay for the insurance of the stock thus treated. Any one with a knowledge of the facts involved should be willing to pay a slightly higher price for fumigated stock, and the writer is of the opinion that the

time is not far distant when fumigated trees will be at a premium. Certainly the nurseryman who destroys all his infested and suspected stock and then fumigates all the trees bought and sold has discharged his full duty to the public.

SUGGESTIONS TO PURCHASERS.

One can conceive of but few greater calamities that might befall a farmer than to have his trees become infested with the San José scale. The insect is most obscure and its attack most insidious; at the same time, its powers of multiplication are phenomenal, and its spread is constant and certain where unrestricted or neglected. Expert entomologists who have attempted to eradicate this insect from orchards have found the problem an exceedingly difficult one. How much more difficult will be the proper treatment of the insect at the hands of the farmer, who in the majority of cases can avail himself of only a part of the resources in skill, remedies and appliances at the disposal of the entomologist? The farmer buys a few infested fruit trees, representing desirable varieties. In a few years some of the trees die. The farmer avails himself, perhaps, of the services of the experiment station officials, and finds that not only has the San José scale killed his young trees, but that from them a considerable part of his adjacent orchard or shade trees has become infested, and learns that only by constant care and outlay of money or its equivalent can these trees be preserved. This picture is not a creation of fancy. There are only too many duplicates in this State. The natural outcome of the unrestricted occurrence of the San José scale on a tree is the death of that tree and the infestation and death of adjacent trees. This is a fair statement of the case at the present time. In the south the fungous disease to which reference has been made has aided in checking the spread of the scale, while in California it is stated that parasites and predaceous insects have rendered a similar service. Until we know that such natural checks appear in this State, and are restricting the increase of the scale, we must depend upon such remedies as experience has shown to be successful, and upon them alone. There are, however, certain precautions indicated

below which should be adopted by all purchasers of nursery stock, in order to prevent as far as possible the introduction of the scale.

1. *Buy First-class Stock.* — In buying trees, as well as in buying other goods, the habit of hunting for bargains will ultimately prove an expensive one. The dealer who has trees to sell at a price greatly below the usual trade rates usually has some potent reason for making the reduction. Cheap trees are usually “culls,” and are most liable to be infested with insect pests. Conversely, clean, thrifty stock, while higher in price, is least liable to harbor undesirable or dangerous insects. An abundance of such stock can be obtained from the nurserymen of this State. It may be well to emphasize the fact that it is more to the purchaser’s advantage to trade with home firms, the condition of whose stock is known, than to buy from remote firms, whose grounds may never have been inspected. In this State, even, one would do better to buy from firms that have had the scale in the past, but on whose grounds none can be found at present, and who are fumigating all stock bought and sold, than to purchase from nurseries whose condition is unknown.

2. *Avoid Tree Peddlers.* — The writer would cast no aspersions on the legitimate agents of responsible and reputable firms. But there are those best described as “tree peddlers,” who go through the farming districts of the State selling trees alleged to possess marvellous fruit-bearing qualities, and delivering second or third class stock, obtained wherever it can be bought the cheapest. A common complaint from farmers and others who have dealt with this class of peddlers is that stock bought of them does not prove true to name. One familiar with their methods could hardly expect the case to be otherwise; and a man who will knowingly falsify the varieties of trees, probably would not be above selling diseased or infested stock for sound, healthy trees. There are plenty of reputable nursery firms in the State who will give the farmer’s small orders the same care and attention paid to those of their largest patrons. Experience in tracing infested stock to its original source has shown that tree peddlers and middlemen have been largely responsible for the dissemination of the scale in this State.

3. *Buy only Guaranteed or Fumigated Stock.* — With the facilities now available for the examination of nurseries, there is no good reason why any nurseryman in the State cannot have his place examined by competent experts, and be placed in a position to guarantee his stock free from dangerous insect pests. This end is best obtained by fumigation; and, as previously indicated, several of our Massachusetts nurserymen are now putting on the market nothing but fumigated stock.

THE OUTCOME.

While the individual loss in many cases has been severe, the writer believes, with J. H. Hale of Connecticut, that the outcome of the occurrence of the San José scale in the east will be for the public good, and that the classes who have lost most heavily will ultimately reap the most benefit. The public has been aroused to the importance of insect damages. State legislation against injurious insects has been enacted. Facilities have been provided whereby the farmer may have to a greater degree than ever before the benefit of expert advice and assistance. Best of all is the awakening of interest in the care of trees. No longer is a fruit tree a machine or a callous organism, to be well treated or abused, as circumstances dictate. The farmer now watches his trees through critical eyes. He is learning of their life, their needs and their possibilities. He is learning the lesson that he should have learned before, — that in tree culture constant attention and thoroughness are the prime requisites of success, and that any other course will ultimately result in failure.

CATCH-CROPS.

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By the term catch-crop is commonly understood a crop which is used to fill a gap, whether caused by the failure of one of the regular crops of the farm or one coming between the main crops. It is a crop which occupies a field which, in the more common farm practice, would remain bare or unproductive. It is often an emergency crop, *i. e.*, a crop not at first planned for, but introduced to supply a want which is a consequence of accident or unforeseen conditions. A rigid regard for the teachings of farm economy would make catch-crops, save those sometimes introduced under the spur of unforeseen contingencies, as regular members of our rotations as any of the crops of the farm. It is not truer that "nature abhors a vacuum" than that the good farmer abhors bare fields. As idle hands find mischief, so also in one sense do idle fields.

IDLE FIELDS MAKE THEIR OWNERS POOR.

The idle field is no more at a stand-still than the idle hand. A growth of weeds on all except the most barren soon covers its nakedness. The increased labor in the care of crops in subsequent years, resulting from the germination of the countless seeds developed in the idle field, will make heavy inroads upon the owner's time or money. The catch-crop may be made to keep down these weeds; and right here is found one of the chief advantages of catch-cropping.

But the weeds upon the idle field may be kept down by occasional ploughing and harrowing, or they may be cut before they ripen seeds, may be argued. True, the weed-seed pest may be prevented in either of these ways; but even so the idle field makes the owner poor. Should he choose

to keep the weeds down by occasionally working the soil, he gives his idle field what is known as a bare fallow; and it must be admitted that bare fallows were once recommended by the best farmers of their time. They are not advised by the progressive farmers of to-day; for it is known, largely as a result of the work of Lawes and Gilbert, that the increased productiveness which often follows a bare fallow is obtained at too heavy a cost. The items are: first, the loss of time; second, the labor of keeping the land clean; and third, the sacrifice to old ocean, to which it is carried by the leaching rainwater, of a considerable share of the elements of fertility which nature renders soluble in the idle field. This sacrifice can be avoided if the soil be kept occupied with the hungry rootlets of a growing crop, for they will arrest the soluble elements in their downward course, and in the growing plant they will be converted into compounds of use and value.

He who chooses to leave his field idle, but prevents production of weed seeds by cutting, does far better than he whose field is the victim of pure neglect; but yet his labor is not directly productive. Even he is made poor. The rule of every good farmer should be "keep the land covered with a growing crop at all times when season permits." As soon as one crop is removed another should follow.

THE SELECTION OF CATCH-CROPS.

The catch-crop, in so far as may be possible, should combine the following characteristics: cheap seed, ability to thrive when sown broadcast, rapid growth, freedom from qualities, either of root or seed, which will cause it to become a troublesome weed, a deep, vigorous root system, the ability to take a part of its nitrogen from the air, hardiness in winter (in the case of some), ability to stand frosts and to grow at a low temperature, and *value*, either as a fodder or for soil improvement.

The importance of these characteristics is in most cases perhaps evident; but concerning some of these points a few words in explanation seem desirable.

The *ability to thrive when sown broadcast* is highly important, since this is the quickest method of planting, and in

most cases the farmer has not much time that he is prepared to devote to the production of a catch-crop. By this system, further, the weeds are more certainly and effectually stifled than in the drill system. The farmer will not, as a rule, wish to *cultivate* a catch-crop.

The catch-crop must be one that will *grow rapidly*; because, coming between or after main crops, the time available is short. Further, the rapid growth stifles and keeps down weeds, while the slow grower, without culture, is itself stifled.

Some plants having most of the qualities above enumerated are yet unfit for catch-crops because they have vigorous root stocks; others it would be unwise to select because of the abundance of seed which would lie uninjured in the ground over winter or for many years.

A *deep and vigorous root system* enables the crop to gather abundance of food even from soils not very fertile. It makes a crop a good *rustler*, to use the expressive western term; and it is the rustler which thrives without special attention to manuring and culture. These the farmer will not care to give to catch-crops in the majority of instances; hence the importance of this characteristic.

Often an important object in the introduction of catch-crops is the improvement of the soil. *Those crops which can assimilate atmospheric nitrogen* serve this purpose most effectually. Other crops return to the soil only that nitrogen which they first take from it; and the soil cannot be enriched in this element by their growth. True, the culture of almost any crop may be made to some extent a means of soil improvement; but only by the culture of plants belonging to the clover family can the store of nitrogen in the soil be increased.

The catch-crop is in many cases highly useful as a cover in winter, to protect the soil from loss of fine particles by wind or from washing. For this purpose we must have crops hardy in winter. It is, of course, self-evident that other crops besides winter annuals often have a value as catch-crops.

Ability to stand frosts is in a very great many cases a highly important characteristic of the catch-crop. It is often sown after the main crop. The time before the probable coming of frosts is short. Only a crop which will continue

its growth in spite of frosts will prove of much value. Further, it is in late fall that the soluble nitrogen compounds are liable to be washed out of the soil by heavy rains unless the soil is filled with the feeding rootlets of growing plants. Only crops which resist frost can prevent this loss.

The catch-crop is grown sometimes chiefly because of its value as a money crop. This, however, in ordinary farming will seldom be the case. It is much more often grown as a means of augmenting the supply of food for the stock of the farm. In other cases, though less frequently, soil improvement by green-manuring is the principal object in view in its culture.

It is possible by judicious selection of crops to realize both of the last-named objects at the same time to a very considerable extent. Sound New England dogma has it, "You can't eat your cake and have it too." In the matter of nitrogen this old saying is disproved. You may grow a crop of clover or clover-like plants; you (or your cow if you prefer) may eat this crop, and by so doing consume an enormous quantity of nitrogen; and yet in the soil upon which the crop was grown, will be found more nitrogen than was contained in that soil at the outset. Is not this "eating one's cake and having it too"? It is those crops which enable us to do this which are among the most valuable as catch-crops.

Of the importance and value of money or of fodder crops it is unnecessary to write; but concerning the possible benefits of green-manuring a few words may be useful.

POSSIBLE BENEFITS OF GREEN-MANURING.

Among the possible and probable effects of green-manuring its relation to the supply of plant food in the soil is one of the most important. Of the important elements derived from the soil which contribute to the nourishment of plants nitrogen is the only one the amount of which can be increased by green-manuring. This may be increased by the cultivation under suitable conditions of legumes (plants belonging to the clover, pea and bean family). These plants, as has been so many times pointed out in recent years, have the capacity to take nitrogen from the atmosphere; and if these plants be

ploughed in or allowed to decay upon the soil, the nitrogen which they have taken from the air becomes available to plants belonging to other families which themselves have not the power to draw upon the air for this element.

It is important to point out, however, that legumes take nitrogen from the air in considerable quantities only when the proper conditions exist. What these conditions are should be made clear. The most important among them are the following: thorough drainage and aeration of the soil, a liberal supply of the mineral elements of plant food, particularly lime, potash and phosphoric acid, and a comparatively small amount of available nitrogen compounds in the soil. It is also essential that the bacteria upon which the assimilation of atmospheric nitrogen depends should be present in sufficient numbers.

Good drainage and aeration are essential because these bacteria will not flourish in soils imperfectly drained or aerated. An abundant supply of mineral elements of plant food is essential because without it the plants of the clover family are unable to make a large growth. With an abundant supply of these elements they can make a luxuriant development, because the supply of nitrogen in the air is inexhaustible.

The bacteria upon which the assimilation of atmospheric nitrogen depends are plants, of microscopic dimensions it is true, but just as really plants as the corn and potatoes of our fields. Being plants they must come from seed, or, what amounts to the same thing, from parts which serve the same purpose as seed. We should not expect a crop of corn or potatoes except the seed be planted, so we cannot expect the development of these bacteria without seed. Fortunately these bacteria, as is the case with many weeds, propagate themselves and are self-seeding. When once established in a field the farmer needs not to supply further seed of witch grass or "pusley." These plants will take care of themselves; so with the bacteria which are connected with the assimilation of atmospheric nitrogen, but there must be a stock of seed to begin with. The beginning was made long ago in the case of all the common plants of the clover family, and the seed of the appropriate bacteria is everywhere abun-

dant. To secure the development of a sufficient number of them it is just as unnecessary to supply more seed as it is to scatter seed of "pusley" in the garden to secure a crop of that weed. It is only when a legume is new in a given locality that it becomes necessary to consider the question of supplying seed of its appropriate bacteria; for while some of the bacteria seed may be present, adhering to the seed of the new crop in the form of dust, the quantity will be insufficient for the best results the first few years.

To supply this deficiency the farmer of to-day may easily purchase *nitragin*, often spoken of as a germ fertilizer; or he may secure soil from the locality where the new crop is known to flourish. *Nitragin* is not expensive, and if used according to directions accompanying it, it has often been found beneficial. The quantity of earth needed is not large, and if scattered and mixed with the soil, as fertilizer would be, it will usually produce the desired effect.

In one other important particular green-manuring has a relation to the supply of nitrogen in the soil. This element is rapidly converted into soluble forms during the summer, and the soil has not the ability to retain these soluble compounds. If the rainfall is heavy and water leaches through the soil it will take these soluble nitrogen compounds with it. This loss can be prevented by keeping the soil filled with feeding rootlets of growing plants. The myriad hungry rootlets will take up the soluble nitrogen and it becomes a part of the plant. It is locked up, so to speak, in the vegetable tissues, and will remain so locked up until these tissues decay.

As has been pointed out, the season when this loss is most likely to take place is in the late autumn; hence, to prevent this loss, or for *nitrogen conservation*, those crops are most valuable which are not affected by the autumn frosts and which will continue to grow as late as possible. Measures to insure nitrogen conservation are self-evidently most important upon the richer soils, which are light and porous in character and which have open subsoils.

Green-manuring cannot increase the store of either phosphoric acid, potash or lime, but it can be made to increase the solubility and therefore the availability of these soil con-

stituents. The feeding roots of growing plants are furnished with a small amount of acid, and this acid takes hold of and makes soluble elements which are not soluble in pure water. The elements so made soluble become a part of the growing crop, and when that crop decays they become available to the succeeding crop, whose labor is therefore lightened because it finds a larger store of available plant food than would have been present had not the green-manuring crop been grown.

Green-manuring increases the store of humus (partially decayed vegetable matter) in the soil, and humus is necessary to the best conditions of fertility and productiveness. It increases the capacity of the soil to retain and conduct water; it promotes beneficial chemical changes among the different soil constituents; changes which result in making originally inert soil materials available as food for plants. A suitable amount of humus contributes largely to the production of that physical condition of the soil which makes it possible to bring it into good tilth and to maintain it in that condition.

The products of the decay of the vegetable matter furnished by green-manuring exert a very beneficial effect upon the soil. Among the most important of these products is carbonic acid. This acid helps to keep the soil chemically active, *i. e.*, to produce beneficial chemical changes which result in making more food available. This acid, further, helps largely to dissolve the useful constituents of the soil, especially the lime and phosphates, thus bringing them within the reach of subsequent crops. This acid, further, attacks the stones and rocks of the soil, helping to disintegrate them. This action is especially important in the case of all rocks and stones containing lime.

The green-manuring crop is useful, further, because while it occupies the land the conditions are more favorable for those processes of fermentation which exert a beneficial influence upon the soil. These processes are favored by the shade furnished by the crop, by the restricted circulation of the air and by the more uniform soil temperature which the occupying of the land by a crop secures. The incorporation of the vegetable matter of the green crop in the soil may be

the means of warming it. The darker color resulting from the presence of humus favors the absorption of heat from the sun, and the process of decay, being in its final effect precisely like combustion by fire, helps to raise the temperature of the soil, though not to an important degree.

Many of the most valuable green-manuring crops are distinguished by the fact that they send their roots into the soil to an enormous depth. Such crops are highly beneficial in two ways: first, by means of their deep roots they bring up from the subsoil food not available to ordinary crops; but having been thus pumped up, as it were, it becomes available to succeeding shallow-rooted crops; second, it has been found that crops which are ordinarily shallow-rooted send their roots much deeper than usual when they are made to follow a deep-rooted green-manuring crop. Thus, for example, Schultz-Lupitz has noticed that the roots of the potato, which ordinarily develop almost entirely near the surface, penetrate deeply into the ground after a crop of lupines, following the furrows left by the decay of the roots of the lupines. This renders the potato less liable to injury from drought, increases enormously the store of food within its reach and so makes the crop more certain and larger.

Green-manuring may be made the means of cleansing the field from weeds, for which purpose, of course, as has been pointed out, only the crops of the most rapid growth are useful. Green-manuring increases the store of organic matter in the soil, and so furnishes the conditions favorable for the multiplication of earth worms, and these, as Darwin has pointed out, by their activities improve the soil in many ways; most important among which are better aeration, bringing of the finer materials to the top, pulverization and increased solubility of its constituents.

Finally, green-manuring may be made to protect the soil from the injurious action of violent winds and from surface washing, for which purposes, as has been pointed out, those crops which occupy the land in winter are by far the most useful, although those which are killed by frosts, if allowed to remain upon the surface during the winter, will prove useful in the same direction.

The list of possible benefits from green-manuring, it will

be seen, is a long one, and these benefits are undoubtedly, under the proper conditions, very great. It may be wondered, then, why the practice is not more general. It might seem that the benefits are sufficiently great to warrant a much more general practice of green-manuring than we find among our farmers; and yet the indiscriminate adoption of the practice is by no means to be recommended. It has its place; but the conditions under which it is best to turn under a catch-crop are, I believe, comparatively seldom met with.

CONDITIONS UNDER WHICH GREEN-MANURING SHOULD BE
PRACTISED.

In the majority of instances a crop which has been grown will be worth more to feed in Massachusetts than it is for turning under. A crop standing in the field has a certain value as a means of soil improvement, — a certain manurial value. It has also, in almost all cases, a certain value as food. It may be used as a food either by pasturing it, or cutting and feeding in the barn. In either case, under proper management the excreta of the animals consuming the crop will be worth as manure about three-fourths as much as the entire crop would be worth if incorporated in the soil. If we turn the crop under, then, in the one case, we get its full manurial value. If, on the other hand, we feed it and carefully save and apply the excreta, or if we pasture and so manage that the droppings are evenly distributed, we have the food value and about three-fourths of the manurial value. The sum of these two in the great majority of instances will be greater than the full manurial value.

There are, of course, conditions under which the crop cannot be profitably fed, either because of the absence of stock necessary to consume it or because of the location of the field. In such cases the turning under of the entire crop may, of course, be wisest.

There can be no doubt that the latter practice is much more often in place upon light and sandy soils than upon better soils. Upon the light and poor soils legumes, not finding nitrogen in the soil, are forced to take it from the air. Upon the richer soils they would take it from the soil itself and

there would be no essential increase in this element as a result of green-manuring.

This has been very strikingly shown by Julius Kühn. Kühn's experiments were carried out in 1891 in Halle, Germany. The soil was a good medium loam. It had produced wheat in 1890. After the wheat was harvested a mixture of 194 pounds of peas, 44 pounds of vetch and 35 pounds of yellow lupine seed per acre was sown. The resulting crop was ploughed under the last of October and rye was sown. The quantity of green material ploughed in amounted to 8,650 pounds per acre. This supplied about 50 pounds of nitrogen. In the spring of 1892 the field was sown to barley, and also an adjoining field, not green-manured. The crops were practically equal under the two methods of treatment. In this case, then, green-manuring produced no appreciable benefit. Kühn estimated that the crop ploughed in would have been worth for feeding about thirteen dollars per acre.

On the other hand, the same experimenter found that on a sandy loam soil green-manuring with field peas sown in the rye stubble after harvesting increased the crop of barley the following year to the same extent as an application of about 175 pounds of nitrate of soda. In the latter case green-manuring paid, while in the first it was attended with loss.

Numerous experiments in the United States, a few of which will be noticed later, established beyond a doubt the possible benefits of green-manuring upon the lighter and poorer soils. It is important to point out, indeed, I have already, in what has been said concerning eating one's cake and having it too, called attention to the fact, that even when the catch-crop is fed the manurial value of its stubble and roots may be considerable. Especially is this true concerning the legumes (clover-like plants).

A great deal of work to determine the manurial value of the stubble of different crops has been carried out at the Storrs School Experiment Station, Connecticut. Some of the leading results of Professor Wood's investigations are shown in the following table : —

*Amount of Roots and Stubble and Valuable Ingredients left in
One Acre.*

KIND OF PLANT AND PORTION ANALYZED.	Roots and Stubble (Water- free).	Nitrogen.	Phos- phoric Acid. P ₂ O ₅ .	Potash. K ₂ O.
	lbs.	lbs.	lbs.	lbs.
Timothy and redbud, stubble and total roots to depth of 3 feet.	8,223	90.1	25.2	55.8
Buckwheat, stubble and roots to depth of 1 foot,	483	4.4	1.3	3.8
Cow pea, stubble and roots to depth of 28 inches,	1,904	25.9	7.5	20.6
Clover, stubble and total roots to depth of 3 feet,	2,906	60.2	15.1	45.4
Vetch, stubble and roots to depth of 22 inches,	1,555	27.2	7.2	27.7
Yellow lupine, stubble and roots to depth of 30 inches.	1,429	15.7	4.9	23.4
Blue lupine, stubble and roots to depth of 30 inches.	1,256	10.7	2.9	12.5
White lupine, stubble and roots to depth of 30 inches.	1,034	11.0	1.9	10.7
Horse bean, stubble and roots to depth of 22 inches.	1,759	31.8	6.1	19.5
Soy bean, stubble and roots to depth of 22 inches,	701	8.6	2.2	5.7

It seems desirable to remark, in connection with this table, that while the work was no doubt accurately done it appears doubtful, in view of known facts and the results of others, whether the results of these investigations do justice to the plants of the clover family. Indeed, in his report the author quotes results of other investigators, showing several times more nitrogen in roots and stubble of clover than his own investigation discovers. Thus, for example, Dr. Voelcker of England is quoted as reporting 100 pounds of nitrogen per acre in the roots only of clover, while Dr. Weiske of Germany is quoted as reporting 180 pounds in roots and stubble. Dr. Weiske is also quoted as reporting in the roots and stubble of rye 62 pounds of nitrogen per acre, of barley 22 pounds, of oats 25 pounds, of buckwheat 45 pounds, of peas 53 pounds and of lupines 58 pounds. Though differing in detail all these results demonstrate, in a striking manner, the fact that the stubble and roots have a large manurial value. It would seem, therefore, in the great majority of instances that the feeding of the catch-crop, the careful saving and application of the excreta of the animals consuming it, together with the manurial value of the stubble and roots, will give us the largest possible returns.

LEADING CATCH-CROPS.

The most important among the various crops which may be appropriately considered under our subject are the following: rye, oats, barley, Hungarian grass, millets, buckwheat, white mustard, rape, English turnips, spurry, vetches, peas, lupines, serradella, crimson clover, sweet clover and red clovers. Possibly used for the same purposes, although requiring a much longer season than most of the above-named crops, may be mentioned the cow pea, the horse bean and the soy bean.

It remains now only to point out the particular uses and adaptations of each of these crops, to give directions for sowing them and a statement, so far as experimental results allow, of the beneficial effects obtained in this country by their cultivation.

Rye. — Rye is one of the most useful catch-crops. It is not capable of assimilating atmospheric nitrogen and so cannot enrich the soil in that element, but it may serve nearly all the other useful purposes for which green-manuring crops are cultivated. It is also a fairly valuable fodder crop, and may be either pastured in fall or in spring or cut and fed. The quality which renders it particularly valuable as a fodder crop is its earliness. It can often be cut in this latitude for feeding as early as May 10, which is much earlier than almost any other crop. As is generally well known, however, the nutritive value of rye fodder is low and it is not palatable except when young. So soon as it is well headed out cattle find it unpalatable. Rye is especially valuable as a means of nitrogen conservation and in affording covering and protection in winter, preventing both damage from wind and washing. It is suited to light soils. It is not deep rooted and so will not bring up soluble food from below to any considerable extent. It may be sown any time from about the middle of August to the first of November, the quantity of seed varying according to the soil and season from two to three bushels.

Oats. — Oats as a catch-crop are comparatively unimportant. They are sometimes sown in July or August to furnish green feed in autumn, but in this part of the State at least

they are very susceptible to rust and the results have generally proved unsatisfactory. Oats are quite hardy and will continue to grow until the ground freezes. They may therefore serve the purpose of nitrogen conservation. They grow quickly and may therefore be employed as a green-manuring crop, but they have no power to take nitrogen from the air and cannot be considered particularly valuable. They are suited to medium and moderately heavy soils. From two to three bushels of seed to the acre are required.

Barley. — Barley is not infrequently grown as a catch-crop with satisfactory results. Sown in July or August it generally proves more satisfactory as a green fodder in autumn than oats. We have found it less liable to rust. Barley hay is considered excellent by those who have used it, but on the whole it is to be regarded as inferior in importance to Hungarian grass and the millets as a source of hay. As a green-manuring crop its position is about the same as that of oats. It cannot enrich the soil in nitrogen, but growing until the ground freezes it may conserve soil nitrogen. It is suited to moderately light and medium soils, and from two to three bushels of seed per acre are required.

Hungarian Grass. — Hungarian grass is probably more often grown as a catch-crop in Massachusetts than any other. When the farmer sees that he is likely to be short of hay he most frequently sows Hungarian grass, and this kind of millet (for it is a millet) fairly deserves the reputation which it enjoys. It is a very quick grower and is finer, therefore more easily made into palatable hay, than most of the other millets. It may also be used as green feed, though for this purpose it must be considered inferior to the Japanese barnyard millet. Hungarian grass is recommended sometimes for green-manuring, but for this purpose it has nothing special to recommend it save its quick growth. It cannot gather nitrogen, it is killed by frost and so is not a nitrogen conserver, and it is not deep rooted. It is suited to light and medium soils, and from one-half to three-fourths of a bushel of seed is required per acre.

Millets. — The number of varieties of millet is very large. We have tried within the last few years twenty-five different kinds. The most important of these, together with the yield

in 1896, are shown in the following table, which gives also the quantity of seed, the height of the plants and the date of cutting : —

Millets. Variety Tests (Plots One-sixteenth Acre Each).

	Quantity of Seed (Quarts).	Height of Plants (Inches).	Date of Cutting.	Yield of Hay (Pounds).
Canary bird seed,*	2	30	Aug. 25,	295
Early harvest, ...	2	36	Aug. 4	325
Mukodamaski (Japanese), . .	2	42	Sept. 8,	540
Golden, ...	2	54	Sept. 8,	610
Golden Wonder, ...	2	48	Aug. 13,	480
Hokkaido (Japanese), . . .	2	47	Aug. 25,	430
Japanese common, ...	2	48	Aug. 25,	475
Hungarian, ...	2	39	Aug. 13,	550
Japanese white broom corn, .	1½	78	Aug. 31,	840
Chinese, ...	1½	51	Aug. 4,	460
Common broom corn, . . .	1½	40	July 28,	450
White French, ...	1½	48	July 31,	310
Red French, ...	1½	34	July 28,	300
Hog, ...	1½	37	July 28,	370
California, ...	1½	37	July 28,	370
Japanese broom corn, . . .	1½	55	Aug. 15,	490
Japanese barn-yard, . . .	1	66	Aug. 13,	620

It should be remarked that in this trial neither the Japanese white broom corn nor the Japanese barn-yard did its best, on account of having been sown too thick. Three of these varieties and Hungarian grass were given a trial upon a larger scale, and the results are shown in the following table : —

* In this table the names under which the varieties were advertised are used in the case of all purchased sorts. The Japanese varieties are of our own importation or production.

Varieties of Millet (One-third Acre Each).

VARIETIES.	Quantity of Seed sown (Quarts).	Date of Cutting.	Yield of Hay (Pounds).
Hungarian grass, ...	6½	Aug. 15,	1,730
Japanese common millet, ...	8	Aug. 26,	2,025
Japanese broom corn millet, . . .	8	Aug. 15,	2,410
Japanese barn-yard millet, ...	4½	Aug. 15,	2,603

The Japanese barn-yard millet in this trial also failed to do its best on account of having been sown too thick for a season so favorable for rank growth as was that of 1896.

The Japanese millets require a longer season for growth than common millets or Hungarian grass, and this is against their use as catch-crops. The Japanese broom corn and the Japanese common millets I consider rather too coarse to make good hay. The Japanese barn-yard millet will make good hay if it can be cured, but it is so succulent that it is extremely difficult to cure and it is not to be recommended as a hay crop. For green feed and to put into the silo it is, however, most excellent. It may be either pastured or cut; the latter I consider best. This millet is enormously productive. Twenty tons per acre of green feed have often been produced upon the college farm, while Geo. L. Clemence of Southbridge reports a yield at the rate of thirty-five tons per acre. As a crop for the silo this millet must be considered valuable. It is more easily grown than corn and makes equally good silage. For the largest crop it must be sown not later than the end of May, although a crop amounting to twelve tons of green feed per acre has been produced from a sowing made as late as July 20. For green feed and for the silo, upon all soils not too dry, this must be regarded as the most valuable of the millets, while for making into hay Hungarian grass is undoubtedly better. As green-manuring crops the millets rank with the Hungarian grass. They have no qualities especially recommending them for this use save that of rapid growth. They are not nitrogen gatherers nor nitrogen conservers.

Buckwheat. — Buckwheat is often introduced as a catch-crop, being distinguished for a specially rapid growth. It is either allowed to ripen or may be left as a green-manure. It has only the quality of rapid growth and the ability to thrive upon light soils to especially recommend it as a green-manuring crop. It is not deep rooted, it cannot gather nitrogen, it is killed by frosts and therefore cannot most effectively conserve nitrogen. In spite of these defects it is very frequently employed as a green-manure, too frequently perhaps, for there are other crops which are superior to it for this purpose which would better be employed. About one bushel of seed per acre is required.

White Mustard. — This is distinguished for very rapid growth and is suited to light and sandy soils. It will grow usually until about the 10th of November. It cannot gather nitrogen, it is not especially deep rooted, but it is a good nitrogen conserver. It may be either allowed to die down and remain as a soil cover through the winter, or it may be ploughed under in November. It furnishes good feed in the autumn for sheep and cattle, but cows cannot be pastured upon it on account of the strong flavor which would be imparted to the milk. The seed may be sown in corn at the time of the last hoeing or cultivation. It will start quickly if the corn is not too thick and by its growth will keep down weeds. It will not itself become a weed. Experiments upon the college farm have shown a slight increase in productiveness as a result of sowing mustard in corn as described. The gain, however, has not been very important. When sown in corn one-half bushel of seed per acre is required.

Rape. — There are two classes of rape, viz., spring and winter. The winter rape, wherever it can be grown, is an extremely valuable crop. Being sown in the autumn it covers and protects the ground during the late fall and winter, begins to grow very early in the following spring and furnishes a large mass of green material to turn under in season for planting most of our crops. Unfortunately winter rape has not been found to be hardy in Massachusetts. Spring rape, the Dwarf Essex variety, has been very successfully cultivated and must be considered a valuable catch-crop. It may be sown either very early in spring, to furnish summer pas-

turage for sheep or cattle, or as a green-manure, or it may be sown in summer, to furnish fall pasturage or as a means of soil improvement. Rape is hardy and will remain green later than most crops, being particularly valuable, therefore, as fall pasturage for sheep and lambs. It is not particularly deep rooted, it cannot take nitrogen from the air, but it is one of the best nitrogen conservers. It is also one of the best plants to keep down or to stifle a growth of weeds. Where the soil is clean and in good condition rape may be sown broadcast, but if the soil is weedy it should be sown in drills. For broadcast sowing from three to five pounds of seed per acre are required; when sown in drills from one to two pounds are sufficient.*

English Turnips. — On account of its very rapid growth the English turnip may often be grown as a catch-crop. It is usually possible to produce an excellent crop after early potatoes, with comparatively little labor, by sowing broadcast if the land is clean. The uses and value of this crop are too well known to require further notice.

Spurry. — Spurry is a crop not generally known to our farmers. It is, however, prominent in European agriculture and has been grown successfully in some parts of the United States. It grows with great rapidity and furnishes fodder which may either be cut or pastured in from four to six weeks after sowing. It will thrive upon lighter and poorer soil than most crops. It is sometimes at first not liked by animals, but after becoming familiar with it most of them eat it freely. Horses, however, never like it. As a green-manure spurry deserves attention on account of its ability to thrive on poor light soils and because of its rapid growth. It is not a nitrogen gatherer nor is it important as a nitrogen conserver. The Michigan Experiment Station † reports very successful experiments in improving the light sandy soils known in that State as the "Jack pine plains." After ploughing in crops of spurry, following crops of grass and wheat have been very greatly improved. From six to eight

* Farmer's Bulletin No. 11, issued by the United States Department of Agriculture in Washington, gives much valuable information concerning rape which might be quoted did space allow, but I am compelled to refer those desiring further information to that Bulletin.

† Bulletin No. 91.

pounds of seed are sufficient. Spurry has been grown upon a small scale on the college farm at Amherst but made too small a growth there to render it valuable.

Vetch. — There are two classes of cultivated vetch, viz., spring and winter. Both are valuable, and the winter vetch is hardy on all well-drained soils in Massachusetts. Vetch is suited to medium or heavy soils. Neither the spring nor winter vetch will do very well without a fairly liberal supply of moisture. The vetch belongs to the clover family and is a nitrogen gatherer. By means of this crop the soil can, therefore, be enriched. Both the spring and winter vetch are valuable for fodder as well as for green-manuring. The spring vetch, as is generally known, is commonly sown with oats or barley, about one bushel to the acre, and winter vetch may be sown with winter rye, the same quantity of seed to the acre. When first grown upon the farm vetches may not do well on account of the insufficient development of the bacteria which are essential to vigorous growth. After a few years it may be expected that these bacteria will become abundant and the growth will be better. It is the winter vetch which is likely to be of most value as a green-manure, for besides serving as a nitrogen gatherer it will serve also as a nitrogen conserver, and will furnish protection to the soil in winter. It grows early in spring, starting up with the rye, and can be turned under in season for corn and similar crops to follow. The following table shows the increase in rye by green-manuring with vetch, and several other crops which are to be spoken of, upon a sandy soil in Germany: —

Increase in the Yield of Rye per Acre on Green-manured Plats over those not Green-manured.

KIND OF GREEN-MANURE.	Date when ploughed under.	Increase in Grain (Pounds).	Increase in Straw (Pounds).
Yellow lupine, ...	Sept. 28,	1,101	1,261
Blue lupine, ...	Sept. 28,	1,343	1,963
White lupine, ...	Sept. 28,	1,352	2,137
Serradella, ...	Sept. 28,	1,241	1,845
Crimson clover, ...	Sept. 28,	903	1,620
Vetch, ...	Sept. 28,	1,077	2,122

The vetch in this experiment was spring vetch, sown May 15, at the rate of 18 pounds per acre, with about one-third of its weight of rye to act as support for the vetch plants. It will be seen that the increase in crop was very large. This is no doubt chiefly to be ascribed to the fact that the vetch stores up a large amount of nitrogen taken from the air.

Concerning the value of vetch as fodder it seems unnecessary to go into details. It is similar in its composition to clover and is relished highly by cows. It can easily be made into hay, as the stems are comparatively fine. About one bushel of seed per acre is commonly required.

Peas. — The common field pea, though requiring a rather longer season for development than most of the crops we are considering, is nevertheless sometimes valuable as a catch-crop. This crop is valuable as fodder and may be used either green or made into hay. Curing is more difficult than in the case of vetch on account of the coarser vines. Peas do best upon medium or heavy soils. This crop is a nitrogen gatherer and is sufficiently hardy so that it may serve also the purpose of nitrogen conservation. The pea is so well known that further notice appears unnecessary. The quantity of seed required is from one and one-half to two bushels per acre.

Lupines. — The cultivated lupines are all annual plants, while our native wild lupine is perennial. Of the cultivated lupines there are three distinct sorts, the white, the blue and the yellow. Lupines do best upon the medium or lighter soils. They are very deep rooted. They are nitrogen gatherers but are killed by frosts and therefore cannot serve as nitrogen conservers. Lupines have little fodder value. They are not palatable to most classes of animals though sheep may be fed a moderate amount of them. They make a very quick growth, and are, because of this and the other qualities named, among the most valuable crops for the improvement of the lighter soils. The table above given shows how large an increase in the succeeding grain crop they are capable of producing when cultivated under the right conditions. About one bushel of seed per acre is sufficient.

Serradella. — This crop is much prized in some parts of Europe, but while it must be admitted that it is a valuable

fodder and, as shown by the above table, also capable of largely increasing the productiveness of the soil, still on account of the slow growth at first I am not inclined to recommend it. Unless it can be weeded and cultivated at the start it is likely to be stifled by the weeds upon all ordinary fields. It seems, further, that our drier climate is less favorable to its growth than the more humid European climate. Nine pounds of seed per acre are sufficient.

Crimson Clover.—Concerning no crop brought to the attention of farmers in recent times has so much been said and written as of this plant. Under the right conditions it is undoubtedly a valuable fodder and one of the most valuable green-manuring plants. The above table shows a large increase in the succeeding crop due to its cultivation. In the United States there have been many reports of success in soil improvement by its cultivation. Perhaps in none of these were more striking results obtained than in an experiment reported by Professor Neale of the Delaware Experiment Station.* I quote from that report as follows:—

“Eight tons 600 pounds of crimson clover from seed, which cost \$1 per acre, added 24 bushels to the corn crop. One dollar invested in nitrate of soda and used as a top-dressing added 6 bushels to the corn crop. Hence, in this case \$1 invested in clover seed returned four times as much as \$1 invested in nitrate of soda. As to the relative amount of labor involved, the sowing of the seed and the broadcasting of the nitrate of soda possibly balance each other. Ploughing down a green crop is doubtless far more costly than ploughing bare ground. This drawback may reduce the above-named apparent gain 25 per cent.”

In Delaware, crimson clover appears to be perfectly hardy; it is uninjured by the winter; but in most parts of Massachusetts this clover is not found to be hardy. It is only in those localities where it can stand the winter that crimson clover is likely to prove of great importance. In such localities it will prove valuable both as a fodder crop and for green-manuring. As a fodder crop it would be valued chiefly because it is ready to cut earlier in the spring than any of our other clovers. Feeding it in large quantities,

* Delaware Experiment Station Report for 1892.

however, has in a few cases been found injurious on account of the balls of hairs from the heads which form in the stomach or intestines. Crimson clover is a nitrogen gatherer. It is not injured by moderate frosts, and is therefore a nitrogen conserver; it is deep rooted and it grows so early and so rapidly in spring that a large bulk of green material may be turned under in season for planting corn and other crops which are planted at about the same time. If sown in spring crimson clover will make one or more good crops upon suitable soil. In order to secure more than one it must, however, be cut about as soon as it begins to blossom. If allowed to ripen any seed it dies, and in any event it will live but one season. Some recommend growing crimson clover in this way in localities where when fall sown it is winter-killed, but it cannot be regarded as particularly valuable save where it will pass through the winter. The quantity of seed required is about twenty pounds per acre.

The common, red, alsike and mammoth clovers are perhaps not, properly speaking, catch-crops. They are, however, valuable crops for purposes of soil improvement, and since so much has been said in this paper upon that subject it seems desirable to mention them. They are all deep rooted, they take nitrogen from the air, they conserve nitrogen, they serve for winter protection of the soil, and must be looked upon as among our most valuable crops for soil improvement. They are particularly deserving of attention on account of the large quantity of the different elements of plant food left behind in their stubble and roots, as shown by the table previously given. Methods of sowing and management are too well understood to demand attention here.

Sweet Clover. — This crop is as yet but little known and cannot be said to have passed through the experimental stage in this locality. It is believed, however, that it may prove a valuable crop for soil improvement. It takes nitrogen from the air, it is very deep rooted, it is hardy in winter and will therefore conserve nitrogen and serve for soil protection, it starts very early in the spring and grows with great rapidity. On the 10th of June this year the average height in a field upon the college farm was two and one-half feet, and at that time it was increasing in height at the rate of an inch a day.

Corn for the silo may be put in from June 10 to 20 with every prospect of success, and it may be doubted whether any nitrogen-gathering crop will furnish so much green material to be turned in previous to these dates as will the sweet clover. European experimenters report very favorable results from green-manuring with sweet clover on heavy soils. In one experiment in Germany, the results shown in the following table were secured with oats : —

Yield of Oats and Straw per Acre with Different Manuring.

TREATMENT.	Grain (Pounds).	Straw (Pounds).
Without green-manuring, no fertilizer, . . .	1,099	1,748
Green-manuring, no fertilizer, . . .	1,645	3,381
Green-manuring, 322 pounds Thomas slag, . .	1,901	3,186
Without green-manuring, 161 pounds nitrate of soda, (harrowed in).	2,723	5,003
Without green-manuring, 161 pounds nitrate of soda (as top-dressing).	1,591	3,455

It will be noticed that the crop was very largely increased where the sweet clover was ploughed in. Similar results were obtained with potatoes. The quantity of seed required per acre is from twenty-five to thirty pounds. It should be sown from about July 25 to August 10. If sown much later it is liable to winter-kill. It is believed that under the right conditions it will give good results when sown in corn at the last cultivation, but this has not yet been demonstrated at Amherst.

The Cow Pea, Horse Bean and Soy Bean. — These crops require a longer season for growth than most coming under this class, but all may be valuable as soil improvers and they will therefore be briefly spoken of. To show their probable value, and for the purpose of comparing them with one another and with the crimson and sweet clover, the following table has been prepared : —

Crops for Green-manuring compared.

CROP.	Green Fodder (Tons).	Nitrogen (Pounds).	Potash (Pounds).	Phosphoric Acid (Pounds).
Cow pea, ...	10	62.0	36.0	20.0
Soy bean, ...	10	168.0	142.0	40.0
Horse bean, ...	12	163.2	84.0	19.2
Sweet clover, ...	12	108.0	101.0	31.2
	Hay, lbs.			
Crimson clover, ...	4,388	84.6	76.2	20.1

Examination of this table shows that the soy bean gives a larger amount of each of the important elements of plant food than either of the other crops under consideration. It furnishes more than double the quantity of each of the important elements of plant food contained in the cow pea. In comparing different crops as soil improvers we have to consider chiefly the amount of nitrogen they contain, for nitrogen is the only important element of plant food which can be increased in amount in the soil by green-manuring.

The cow pea is highly praised in many quarters as a crop for soil improvement. The soy bean, in my opinion, possesses numerous advantages over it for that purpose. The cow pea does not ripen seed here while the soy bean does. It is well known that legumes take nitrogen from the air in largest proportion as they approach maturity, hence the crop which matures will enrich the soil in this element to a greater extent than one which does not. The cow pea, while doubtless valuable further south, both for fodder and for green-manuring, is therefore believed to be inferior to the best varieties of the soy bean for these purposes.

The number of varieties of this bean is large. Among those experimented with at Amherst the medium green proves to be best. This is confidently recommended for fodder, to be used green or to be put into the silo with corn or with millet, or for green-manuring. It must be planted in drills; it does best upon medium or moderately heavy soils and about one-half bushel of seed per acre is required.

The horse bean is not recommended for Massachusetts as it seems to be subject to blight, which seriously lessens its productiveness.

TUBERCULOSIS AND THE MILK SUPPLY.

BY GEORGE M. WHITAKER, M.A., ASSISTANT EXECUTIVE OFFICER, MASSACHUSETTS DAIRY BUREAU.

During the past few years many statements have been made about possible danger from the use of milk on account of the chance of its containing disease germs. These assertions coming from good scientific authorities, have been frequently repeated in the newspapers, which are always on the alert for what is novel or startling, and the claims have lost nothing at the hands of the sensational press. Sometimes a scientific man has stated the case in rather startling language. All this has created considerable agitation and tended to curtail the consumption of milk. At times these statements have been coupled with suggestions for removing the danger and for milk and dairy inspection, but by methods somewhat radical and arbitrary. A natural reaction from these assertions and recommendations has led, in not a few instances, to a denial of the statements of the scientific experts. Much personal animosity and bitter feeling have also been involved, and it has been difficult to treat the question calmly and candidly. The times hitherto have not seemed ripe for a judicial discussion of this topic. Possibly it can now be done in a way that will not only convey facts to the public, but also present the facts in their proper relation to other facts, and give their true bearing upon the general milk and food situation. This will furnish the public needed information, will help producers, stimulate the consumption of milk, and place the scientific bearing of the case on a solid footing and in line with good judgment.

By way of introduction, it should be stated that danger besets us on every hand during every day of our existence. The very act of living is full of possible dangers, — in the air we breathe, the water we drink, the food we eat, and all the

incidents connected with our daily lives. The germ of fever or other contagion may enter our systems through food, drink or air; the dog may go mad; the bull may gore us; the railroad train may be derailed; our horse may run away, or the wagon break; the mowing machine may upset and injure us; lightning may strike, or the engine blow up; electric wires may bring sudden death; and the grade-crossing may menace our existence. Wherever we go and whatever we do, possibilities of danger to life are on every hand. The truth of this is seen not only in the experience and observation of every person, but in the news items which the daily papers bring to us each morning and evening. And yet the danger which exists exists chiefly in the aggregate. The personal chances of injury are very slight. The proportion of people injured to all of the human race is small; our individual chance of immunity from accident is large.

But there is one marked difference between the dangers from physical accident and the danger from disease germs. Surg.-Gen. Alfred H. Holt of Cambridge read a lecture before the State Board of Agriculture in Springfield in 1887. It was my duty to report that lecture, which I did by interviewing Dr. Holt at his home in Cambridge, and preparing an abstract from the manuscript in advance of its delivery. It was an explanation of the germ theory of disease, including typhoid fever, diphtheria, tuberculosis and other diseases, in which he said that this explanation of the origin of many diseases "is more a condition that has been forced upon us by the teachings of the microscope and the laboratory than a theory." After preparing the report, I asked him how it happened, in view of the prevalence of these germs and the ever-present possibility of their getting into our systems, that there was any human race left. His explanation made a strong impression upon me at the time, and has often been recalled during the heated discussions over the possibilities of any germs being conveyed in milk. The doctor explained clearly that health is the natural condition of the human race, and that the forces of nature are working for health all of the time. The germs get in their deleterious work chiefly when nature is in some way handicapped, — by weakness or other abnormal conditions, — rendering the system favorable for

their reproduction. Consequently, in the majority of cases the germs do no harm.

These dangers, — whether from physical mishap or germs, — are so common and the individual risk so slight that we go about our daily duties without fear, maybe carelessly; we know that even in the case of war a large majority of the persons who go to the front return alive. Even though a horrible ocean calamity, bringing hundreds to an untimely end, sends a thrill of horror through the community, the steamers next sailing are loaded with passengers, each one believing that the probabilities of a similar accident happening to him are very slight. The railroad accident, causing many deaths, does not decrease travel. In other words, these various possibilities of injury or death create no panic or scare in the community. But, on the other hand, they are not viewed with stolid indifference. They lead to extra precautions and increased safeguards.

Though the railroad accident does not cause any decrease in railroad traffic, though the public, with what appears to be almost reckless carelessness, journeys the next day as if nothing had happened, the accident does not pass unheeded. Its causes are carefully studied, the danger of a similar occurrence is investigated, and the expert mechanic in his workshop and study evolves an air brake, an interlocking switch, an automatic signal or some other safety appliance; and traffic is all the more safe as a result, but without panic. The ocean horror sets investigators to thinking, and some one devises new means of signalling, invents new processes for increasing safety in a fog, or suggests new paths for the ocean traffic. The falling of an electric wire, causing the death of a passer-by, or the crossing of an electric light wire with a telephone wire, setting fire to valuable buildings, does not decrease the use of electricity, and the dangers therefrom are not vociferously advertised, to alarm the public; but careful investigation follows, then come days and nights of study and experiment, and finally some expert electrician devises a method for insulating the wires or for operating them satisfactorily under ground; the danger disappears, while the comfort resulting from the use of these modern conveniences increases.

All this, it seems to me, teaches us a lesson as to the milk question, — the dangers from germs, the way to face the danger, its seriousness, and the course to be adopted. Within a few years wonderful advances in bacteriology have been made, and facts which ought not to be disputed, conservatively stated, are these: It has been found that many kinds of disease are caused by microscopic germs; these germs have been actually seen with powerful magnifying glasses, and identified so as to be as well known to the microscopist as is any human being to his neighbors and friends; milk has many characteristics that make it a medium to which germs can readily gain access, and by which they may be communicated to the human system; there is an abundance of authority for the assertion that, under conditions which sometimes exist, milk *may* be, and probably is, a medium for conveying tuberculosis. This cannot be denied or disproved. There is an element of danger in the use of milk.

This danger, owing to circumstances hinted at above, but which there is not space to amplify, has not been treated like the dangers incident to railroad travel or the use of electricity; but it has been popularly discussed by extremists, — those who have exaggerated the real relative danger, and those who have belittled it. The trouble with some who have discussed the possibility of germ contamination of milk is that they have lost sight of the true relative position of affairs. While with one eye they have looked through the microscope at the bacillus and seen it greatly enlarged, they have looked at remaining qualities of milk with the other eye unaided; hence they see the microscopic germ out of proportion to the rest of the world. This has caused them to tell truth, but in some instances to present it out of a proper relation to other things. In attempting to refute this error, other persons have carelessly but honestly gone to the other extreme of denying the statements of the scientific observers, declaring the whole germ theory to be a hoax and a humbug. They have pointed out the well-known fact that people have used milk in large quantities ever since history began; that the population of the world has steadily grown, and that the average life of man has been increasing; that tuberculosis is

decreasing. This kind of talk has gone so far that in one case we have read of a man offering to take daily potions of milk impregnated with the bacilli of tuberculosis, as an object lesson proving their harmlessness.

I am familiar with a town through which a railroad has run for many years. One of the principal streets crosses the track at grade, and hundreds of people pass and repass every day. I have frequently crossed the rails at that point myself, without any apparent risk. But one day an omnibus with some of the most promising and best-known young men in town was being driven over the crossing. In some way the driver failed to be aware of an approaching train, which crashed into the vehicle, killing and maiming some six or eight persons. A thrill of horror ran through the community, and a prompt recognition of the danger of the crossing was on every one's tongue. Immediately it was decided that something must be done, and the corporation was compelled to station a flagman there. At that time, would an offer from me to walk to and fro over that crossing every day for a year, as proof of its comparative harmlessness, have availed anything, or, if accepted, would it really have proved that there was no danger? Would the absence of any accident to one hundred thousand people who might cross the rails for the next ten years prove that no danger existed? In spite of the small percentage of injuries, in spite of the relatively small probability that any specified individual would meet with danger, the expense of such precautions as flagmen or gates was wisely deemed necessary.

What shall we do about the milk supply? Exactly what is done in the case of the railroad or electric wire accident. The quiet, unostentatious work of student, experimenter and producer alleviate these dangers. Even if an appeal to restrictive legislation is necessary, newspaper broadsides, illustrated with views of blood-curdling horrors, are not essential, and may even retard the good cause.

It is a fact that tuberculosis is now on the decrease, owing to more knowledge of it and how it should be controlled. In Boston, from 1846 to 1865, the number of annual deaths from consumption per 1,000 of population ranged from 40 to 48. From 1886 to 1896 they had declined to from 25 to

40. The average from 1891 to 1896 was 29, against 47, the average from 1851 to 1855. But the fact remains that tuberculosis is still the most fatal disease among us. It kills its hundreds where other well-known diseases kill their tens; and the fact that it is decreasing should not preclude still further efforts along the line of precaution and prevention.

We desire to urge with emphasis that there is truth in both sides of the contentions of the last few years. But we believe that, with all that can be said against it, milk is relatively one of the most healthful foods there is, a great boon to the human race, and a food product which should be consumed in much larger quantities than at present. We believe that, especially in the large cities, more people suffer from the want of it than from its use. At the same time, there is an element of danger in it, just as there is an element of danger in grade crossings, in exposed electric wires and thousands of other things.

Science is making progress in showing us how to reduce these dangers; in surgery, the deaths have been wonderfully reduced during the past few years. The studious investigators and the intelligent producers of milk should work together, each counteracting any tendency of the other to excess, and thus bringing about true and healthy progress. There should be a hearty co-operation between conservative scientists and enterprising producers. The scientist should tell the truth, carefully and calmly, and in the correct perspective, with needed explanations and qualifications. The producer ought to have a receptive mind, eager to learn, and anxious to take every reasonable precaution to produce a harmless product. The lives of weak infants or debilitated invalids may be in his keeping. He should realize the full extent of his responsibility.

A gentleman once said to me that he considered the charges about the possible dangers from milk as wholly false, and a scare got up by selfish men for selfish purposes. My reply was an illustration from my own family. One member, perfectly healthy in every way, so far as could be ascertained, drank milk freely and with impunity, without thought or care of the result. Another, in feeble health, the object of much solicitude, was not allowed to drink milk until it had been

carefully boiled, to kill any possible germs of tuberculosis. After narrating the case, my sceptical critic replied that he would have done the same thing in his own family, under similar circumstances. In that admission he gave away his whole case. Health is the natural condition of mankind, and when nature is given fair play she will do much to counteract any small lapses from obeying her laws. We admit that a person in rugged health might under favorable conditions take germs of tuberculosis into his system with impunity, for the kindly functions of nature in the digestive processes and elsewhere might eliminate the germs from the system, and no ill effects would result. But in the case of debilitated, sickly or weak persons, the conditions are different, and danger may exist; not in any emphatic way, to cause alarm or panic, but enough to cause prudence and care. Let an alarm of fire be given in a crowded theatre, and a panic ensues; usually the danger by the horrified people crowding against and trampling upon one another is much greater than the danger from fire. We must face the milk question with every effort to avoid panic, but honestly realizing the truth. As the world advances and popular intelligence increases, more and more care will be taken in the milk supply, more and more confidence will be felt in it by the consuming public, and, as a result, larger and larger quantities will be consumed. Progress will help both consumer and producer.

MILK AND CREAM.

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GENERAL STRUCTURE OF THE UDDER OF THE COW.

The udder of the cow consists of two milk glands, a left and right, separated from each other by a fibrous tissue (ligamentum suspensorium mammarum). This tissue layer, or wall of division, is connected by elastic muscles with the connective tissue which surrounds the glands, and also with the muscles of the belly, thus holding the milk glands in position.

The two milk glands are each of a reddish-gray color, and consist, properly speaking, of a glandular structure known as the gland basket. In case of ordinary mature milch cows, each gland is about 6 to 12 inches in depth and 9 to 20 inches in length. The glandular mass may be divided into lobes, lobules and alveoli. Plumb makes this clear by likening the lobe to a bunch of grapes, the lobules to a single grape and the alveoli to smaller divisions within the single grape. The lobules of the gland are surrounded by a fully developed network of capillary vessels, in which the materials for the formation of the milk circulate through the numerous lymph tracts. The alveoli are microscopic terminations of extremely fine canals. They are covered externally with a structureless membrane, and internally are lined with a continuous single layer of epithelial cells. These cells have a diameter of .04 of a millimeter. When the cow is in milk they are swollen and protrude into the alveolian cavity. The microscopic canals, of which the alveoli are the enlargements, unite together among themselves into ever-widening ducts, — the milk ducts, — and end eventually in large, hollow cavities, the so-called milk cisterns or reservoirs.

These cisterns, four in number, situated above each teat, extend upwards into the gland and downwards almost to the end of the teat. The teats, two for each milk gland, are encircled at the lower end with numerous fibres, forming the sphincter muscle, which prevents the escape of the milk under ordinary conditions.

The individual lobules are enveloped in connective tissues, which unite them in a glandular mass, and this connective tissue is in turn covered with adipose tissue, and the whole udder is enveloped by the skin.

FORMATION OF MILK.

In spite of the many investigations concerning the formation of milk there is very little positive knowledge on the subject. Previous to 1840 it was held that the milk glands separated the materials for the formation of milk directly from the blood. Later it was proved that none of these materials existed ready formed in the blood, so the above theory was abandoned. The second theory was suggested by Virchow, formulated by Will, and supported by Viot. They claimed milk to be a fatty degeneration of the *epithelial cells of the alveoli*, — a liquefied cell substance. Heidenhain opposed this view, and claimed that the epithelial cells do not suffer degeneration, but rather only their free ends, the renewal of the cell material taking place at the opposite end. C. Partsch holds that the formation of milk fat is not a result of fatty degeneration, “but rather a special activity of the cell in the true sense of the word.”

Rauber advanced the idea, as a result of his studies, that the fat, casein and milk sugar are derived from the white blood corpuscles. He claims that the lymph rather than the blood vessels are found in direct contact with the alveoli, and that the white blood corpuscles are diffused through the veins and the lymph vessels and then further into the epithelial cells, and there are transformed into the various milk constituents.

It is probable that the milk is not gradually formed and stored in the udder during the day, but rather that the epithelial cells of the alveoli become very much enlarged with various substances going to form the milk, and that just pre-

vious and even during milking these distended cells break, and the milk thus distributed in the udder is drawn off by the milker. The enlarged udder of the cow for a few hours just previous to milking is not wholly due to the amount of milk it contains, but rather to the distended or congested condition of the glands.

From the above brief outline of the several theories, it is apparent that as yet we have but very little definite knowledge of what actually takes place in the glands which results in the production of the white fluid termed milk. It is probable that the fat is derived to some extent from the fat of the blood, but is formed largely as a result of cell activity, and is, therefore, a secretion. The formation of milk sugar and casein is still largely a matter of conjecture.

It is evident, however, both from practical and scientific observations, that the production of milk depends firstly upon the large development and great activity of the milk glands, and secondly upon the capacity of the animal to consume and digest large amounts of food in order to supply these glands with an abundance of the necessary raw materials.

PROPERTIES OF MILK.*

Milk in its normal condition is a pure, almost white fluid, and perfectly opaque in large quantities. This lack of transparency is due partly to the fat in suspension and partly to a suspension of the nitrogenous and mineral matter. It has a slight smell and a mild, rich, slightly sweetish taste. It possesses a slight amphoteric (alkaline and acid) reaction, due probably to the presence of alkaline carbonate and neutral and acid phosphates. When allowed to stand for any length of time, a multitude of minute fat globules rise to the surface, and form a layer of cream. By continuous standing milk coagulates. Coagulation can also be brought about by the addition of small quantities of acid.

THE INGREDIENTS OF MILK.

The larger part of milk consists of water, which contains a variety of substances in suspension and solution. The

* In considering this subject it will be understood that cow's milk is always meant, this being practically the only milk used in the United States.

substances to a considerable extent dissolved in the water are casein, albumen, milk sugar and the ashly matters. This solution forms the so-called *milk serum*. The fat exists in the milk in suspension, in the form of very minute microscopic globules. They are semi-solid and form with the serum what is termed an emulsion.

1. *Milk Fat*. — The fat globules in milk vary in size from .0016 of a millimeter to .01 of a millimeter ($\frac{1}{25000}$ to $\frac{1}{1500}$ of an inch), *e. g.*, microscopically small. The smaller the more numerous they are. As a rule the globules in the milk of the Jersey and Guernsey cows are larger in size than those in the milk produced by Holsteins or Ayrshires. The globules are largest in the milk of newly calved cows. The percentage of fat in the milk product of the United States may be said to vary between 2.25 and 8 per cent with a probable average of 4 per cent.

Milk fat contains two kinds of fat, the so-called non-volatile and volatile fats. Neutral non-volatile fat is a combination of glycerine with fatty acids, such as the palmitic, stearic and oleic acids. There is about 92 per cent of non-volatile and 8 per cent of volatile fats in the fat of milk. Duclaux has estimated butter fat to be composed of the following separate fats: —

	Per Cent.
Palmitin, stearin, olein, with traces of myristin and butin, ...	91.50
Butyrin, ...	4.20
Capronin, ...	2.50
Caprylin, caprinin and traces of laurin, ...	1.80
	100.00

Butter consists largely of milk fat (85 per cent) and hence the value of milk for butter depends upon the quantity of fat it contains.

2. *Milk Albuminoids (Nitrogenous Matter)*. — The albuminoid or nitrogenous portion of milk contains five distinct substances, namely, casein, albumin, lactoglobulin, lactoprotein and fibrin.

Casein forms about 80 per cent of the total albuminoids. It exists in the milk, combined with lime in a semi-dissolved condition, and possesses a certain amount of opacity (lack

of transparency). The proportions in which the casein and lime exist in combination are 100 parts of the former to 1.55 of the latter.

Casein forms the chief constituent of the milk curd, which separates out when the milk becomes sour. Casein is one of the two chief ingredients of cheese. It is that part of the milk which forms flesh (lean meat), either in the growing animal or the human being.

Albumin differs from the casein in being in a state of complete solution in the milk, and in separating out in the form of scum when the milk is heated from 158° to 167° F. While it exists in comparatively small amounts in normal milk, it is found in large quantities in the colostrum (first milk after calving).

Lactoglobulin, another albuminoid, is present in very minute traces in milk. It resembles the albumin.

Lactoprotein is present in milk to the extent of about .13 of 1 per cent. It is found in solution after removing the casein, albumin and lactoglobulin. It has been named albuminose, galactin, gelactine, etc.

Fibrin is also claimed by Babcock to exist in milk in quantities of .1 of 1 per cent.

3. *Milk sugar* was discovered in milk late in the seventeenth century. It is a crystalline body, white in color, and has the same chemical formula as cane sugar. It occurs only in milk, where it is found in a state of perfect solution. It is not as easily soluble in water as cane sugar, and possesses only a slightly sweetish taste. The amount of such sugar in normal cow's milk varies from 3 to 6 per cent with an average of about 5 per cent.

4. *Milk ash*, or mineral constituents, consists of potash, soda, lime, magnesia and iron, united with phosphoric, hydrochloric, sulphuric and carbonic acids. The total amount of ash is small, averaging about .75 of 1 per cent. The potash, lime and phosphoric acid form the largest proportion of the ash. The ash, as a source of food, serves to build up the bony structure of the body.

In addition to the above principal ingredients of milk, small quantities of other substances have been recognized. Citric acid has been found to the extent of .1 of 1 per cent.

combined with iron and magnesia. Very minute quantities of urea, lecithin, kreatin, hypoxanthin, leucin and tyrosin have also been recognized, formed without doubt from the partial decomposition of the albumin during the process of digestion in the animal body.

Gases in small quantities, such as nitrogen, oxygen and carbonic acid, also exist dissolved in the milk.

While it is not possible to give any absolute figures for the composition of milk, the following will show the approximate relative proportions of the several ingredients :—

	Per Cent.
Water, ...	87.00
Fat, ...	4.00
Albuminoids, { Casein, ...	2.90
{ Albumin, ...	.50
{ Lactoglobulin, }	.15
{ Lactoprotein, }	
Milk sugar, ...	4.75
Ash, ...	.70
	100.00

The following figures give the approximate compositions of the milk of different breeds :—

	Total Solids* (Per Cent).	Fat (Per Cent).	Solids not Fat (Per Cent).
Average milk, ...	13.0	4.0	9.0
Holstein, ...	11.8	3.2	8.6
Ayrshire, ...	12.5	3.7	8.8
Shorthorn, ...	12.9	3.8	9.1
Devon, ...	13.4	4.4	9.0
Jersey, ...	14.7	5.0	9.7
Guernsey, ...	14.7	5.0	9.7

While the above figures can be taken as types, they do not mean that every cow of a distinct breed will give milk of the above composition. In fact, a great many Jerseys pro-

* Containing milk sugar, curd and ash.

duce milk with 4 per cent of fat, and families and individual cows of Holstein breed yield milk as rich as do many Jerseys or Guernseys.

Variations in the quality of milk are due to a variety of causes.

The substance showing the greatest variation is the fat, while those remaining more nearly constant are the milk sugar and the ash. The milk is generally poorest in quality, *i. e.*, contains the most water, for the first few weeks after calving, and grows gradually richer till within a few months before calving. As the cow becomes dry the solid matter increases quite rapidly. With some cows the composition of the milk remains nearly constant from the fourth week until the end of the sixth month after calving, while with others a gradual increase in richness is observed. Morning milk is quite frequently poorer in fat than evening's milk. This is largely due to the unequal periods between milkings. As a rule, the shorter the time between milkings the richer the milk in fat and *vice versa*. Cows milked three or four times daily, produce milk richer in fat than those milked but twice. The composition of a single cow's milk will vary from day to day. Such variations are to be attributed to effects of the weather conditions, environment, change of food, etc.

The quality of milk from different portions of the same milking differs widely. The first part of the milk drawn is poorest in fat and the last richest.

Feed has no marked effect on the composition of milk. This statement, however, needs to be qualified. An animal that is poorly nourished, by receiving insufficient food or food containing an excess of carbohydrates and a lack of protein, will give milk of somewhat poorer quality than animals normally fed. An excess of fat in the food will tend to increase the fat in the milk, providing the animal is able to digest and assimilate the fat. Feed appears to affect, to an extent, the quality of the fat in the milk. Thus gluten and linseed meals tend to make a softer oily fat, while cotton-seed meal produces a hard fat. The other milk ingredients are but little changed. Certain foods also tend to impart objectionable flavors to milk.

Different breeds of cows, as is well known, give milk of varying degrees of richness. Thus Guernseys and Jerseys produce milk with the highest amount of total solids, and Holsteins give milk with the lowest amount. Individual cows, however, show wide differences, irrespective of breed. It is not unusual to find individual Holsteins giving milk as rich as some Jerseys.

PURE AND IMPURE MILK.

Pure milk may be defined as the natural product of a healthy cow, drawn and cared for in a cleanly manner. Milk from diseased cows, or cows in a low physical condition, cannot be considered as pure. Milk from cows affected with tuberculosis of the udder is positively dangerous. There is still a difference of opinion as to whether milk from cows moderately affected with tuberculous lungs, glands or other internal organs is positively dangerous, but in the light of present knowledge, it must at least be viewed with suspicion. Milk from some Holstein cows does not contain over 11.5 per cent of total solid matter, and 3 or even less per cent of fat. Such milk, other things being equal, must be considered pure and healthy, only not as rich as that from other cows. Milk drawn from a healthy cow is perfectly sterile, and if the proper precautions are taken, it is possible to keep it for a considerable length of time without change. As soon as the milk is drawn, conditions present themselves which cause the milk to change and become impure.

Impure milk may result from dirty cows, dirty stables, dirty milkers and dirty milk pails. Milk absorbs a bad odor very rapidly, and if left exposed to a bad atmosphere will very soon become tainted. *The primal cause of all the changes which milk undergoes is the result of bacteria.*

WHAT BACTERIA ARE.

Bacteria may be defined as microscopic, one-celled plants, belonging to the lowest plane of vegetable life. There are three typical forms, the spherical, elongated, and spiral. These forms may be likened to a ball, a short rod and a corkscrew. Scientifically they are classed as coccus, bacillus and

spirillum. These minute plants are of course absolutely invisible to the naked eye. In fact their average diameters may be said to be one thirty-thousandth of an inch. The elongated form have an average length of from .0004 to .001 of an inch.

Bacteria reproduce themselves by division and by spores. By division is meant that a single plant develops a cell wall within itself, and very shortly separates into two plants. Spores are small round bodies formed within the plant, which are thrown off, and, under suitable conditions of heat and moisture, rapidly develop into full-grown bacteria. Bacteria multiply with wonderful rapidity. Many species, under suitable conditions, will reproduce themselves within half an hour.

Bacteria find their way into milk as soon as drawn. They fall in from the body of the cow, from the hands and clothes of the milker, and from the dust of the air. Under the most cleanly conditions large numbers of bacteria are found in milk, while when the conditions are reversed, the number is marvellously increased. It may be said that one twenty-eighth of an ounce of milk has been found to contain from 6,000,000 to 170,000,000 bacteria. Bacteria develop most rapidly at a temperature of 100° F., and their development is checked the nearer the temperature is kept to the freezing point.

CHANGES IN PURE MILK.

Sour Milk. — One class of bacteria feeds upon the milk sugar of the milk, and as a result lactic acid is formed. This acid gives the milk its sour taste, and causes at the same time the casein or curd to separate out. The dirtier the animals, stables, milker and milk vessels, the larger the number of bacteria that will find their way into the milk, and the more quickly will the milk become sour. Milk sours more rapidly in hot weather, because the temperature is better suited to the rapid development of the bacteria.

Bitter milk is sometimes due to improper food, or condition of the animal, and also to certain bacteria, which, having gained access to the milk, attack the casein and decompose it, producing butyric acid, peptones or other substances.

Ropy or stringy milk is also caused by bacteria, which render the milk more viscous, or cause it to adhere to anything that touches it, drawing out into threads of considerable length.

Red milk is sometimes caused by the actual presence of blood in the milk, due to a wound in the udder or to the effects of certain feeding stuffs. An excess of ensilage has been claimed to produce a bleeding of the udder. Most frequently red milk is due to the presence of bacteria (*Bacillus prodigiosus*). Its growth in the milk is accompanied by the production of a coloring matter, especially near the upper surface of the milk.

Blue milk is the result of the production of a blue pigment of *Bacillus cyanogenus*. Blue patches are sometimes noticed on the surface, or the whole surface may become covered with a blue coating.

Soapy milk is occasionally observed, also occasioned by specific bacteria.

There are forms of bacteria which produce various gases in milk, as well as alcohol and similar substances. Milk being a favorable medium for the growth of all kinds of bacteria, it occasionally happens that the bacteria producing typhoid fever, diphtheria and similar contagious diseases gain access to milk, and result in the milk becoming a transmitter of these most serious diseases.

The bad odors that arise in the stable, and not infrequently in the dairy house, are caused by bacteria which are at work decomposing various kinds of filth found there.

The lactic acid producing bacteria are by far the most numerous in milk, and hence the most ordinary change in milk consists in the process of souring. Sometimes these bacteria are overpowered by others, and result in the various disagreeable conditions above referred to.*

* Whenever the producer is troubled with bitter, colored or stringy milk, his first effort should consist in a thorough cleaning of barn, cows, dairy house and dairy utensils. The barn, cows and dairy house should be thoroughly cleaned of dirt and dust, and then sprayed, the barn with water containing 5 pounds of carbolic acid for 100 pounds of water, and the dairy house with 6 ounces of bleaching powder to a gallon of water. Carbolic acid can be purchased of Eimer and Amend, 205 Third Avenue, New York, at about 75 cents per gallon. When ordering, state that 100 per cent crude liquid is wanted.

It has become evident from the foregoing that practically all of the various troubles which result in bad milk can be directly or indirectly traced to the different forms of bacteria, which are especially abundant wherever filth of any kind is to be found. This leads us to a brief consideration of

MODERN METHODS OF PRODUCING AND HANDLING PURE MILK.

Healthy Cows. — It is evident that, in order to have pure milk, the producer must start with healthy cows. Diseased animals, kept in dark, poorly ventilated stables, cannot give healthy milk.

Good Feed. — Practically all kinds of coarse feeds grown upon the farm or concentrated feeds sold in Massachusetts will produce pure milk if fed at the right time, in suitable quantities. Some feeds, as cabbages and turnips, because of a particular flavor, must be fed sparingly and directly after milking. Partially decayed potatoes, cabbages, ensilage, etc., ought to be avoided.

Good Water. — Producers make a great mistake in not looking carefully after the quality of water drunk by their cows. Water receiving the drainage from the barn ought never to be used.

Clean Animals. — Farmers are in error in thinking that they can produce clean milk from filthy animals. More or less dirt will most certainly find its way into the milk, with a corresponding bad effect. Animals which are well bedded and cleaned daily, present a far more attractive appearance to the eye, and will nearly if not quite pay the cost of the extra labor by the increased milk flow.

Clean Barns. — It is fully realized that farmers producing milk for ordinary trade cannot afford expensive barns. Force of circumstances causes them to house their animals in very plain, inexpensive buildings. It is possible, however, for farmers to give their animals plenty of light, by placing a sufficient number of windows on the south and west sides of the barn. Barns can be ventilated cheaply by running ventilating shafts from floor to roof. Barns can be kept clean with very little labor, if the producer has sufficient interest to see that it is done. A force pump and plenty of white-

wash will accomplish wonders. Barns can be further disinfected by using a spray nozzle on the pump, and occasionally spraying the interior with water containing five pounds of carbolic acid for every hundred pounds of water. The gutters, stalls and platforms can be sprayed with the solution with most excellent results.

Handling Milk.

Before milking, the udder and belly of the cow should be well brushed. This takes but a few minutes and is a valuable preventive of impure milk.

The milker should wash his hands before milking, and wear a light inexpensive suit, consisting of overalls and jumper, which should be frequently washed and kept outside the stable. This suit should be removed and well aired immediately after milking. Some producers of so-called "fancy milk" compel their employees to wear white duck suits; but, while this makes a better appearance, it is not at all necessary.

The vessels in which the milk is drawn and kept must be thoroughly clean. All milk vessels should first be rinsed with cold water, then thoroughly scalded with hot water, drained and well aired. Unless one is very particular, milk will accumulate in the seams of milk pails and harbor enormous quantities of bacteria, producing the most objectionable results, and completely puzzling the producers as to the cause of the trouble.

As soon as the milk is drawn in any quantity it should be removed from the barn to the dairy house. It is a great mistake to have a dairy room opening directly out of the cow stable, for it soon becomes thoroughly impregnated with the barn odor. The dairy house should be sufficiently far removed from the stable to allow a good circulation of air between it and the stable. The milk should here be thoroughly strained, aerated and cooled.

Aeration consists in allowing the milk to run in a thin layer for a distance, exposed to the action of pure air. This is not absolutely necessary, but it most certainly aids in removing the slight animal odor, as well as the various gases the milk contains. It at the same time cools the milk to a temperature of 50° F. The two most common forms of aera-

tors and coolers in use for this purpose are the Star and Champion coolers. These simple contrivances can be found at all dairy warehouses. The Champion has the advantage of allowing a piece of ice to be placed in the water used in the cooler, and but very little water is actually needed. In case of the Star cooler, a current of water must constantly run through the cooler to secure the best results. Milk as it comes from the cooler is drawn into cans or other vessels, and still further cooled by being immersed in vessels containing ice water as near the temperature of 38° F. as possible, and held there till marketed.

It will thus be seen that the secret of having clean, pure milk consists in keeping out all of the bacteria possible, by observing the most rigid rules of cleanliness, and in preventing those that unavoidably gain access, from becoming active, by holding the milk at as low a temperature as possible. Bacteria being plants, it is impossible for them to grow when the temperature is within six or eight degrees of freezing.

CREAM.

Cream may be defined as that portion of the milk in which has been gathered the largest proportion of fat. It is composed of the same substances found in the milk, but these substances do not exist in the same relative proportions. Cream separates naturally from the milk because of the difference in specific gravity between the globules of fat and the remainder of the milk (milk serum). If milk is allowed to remain at rest in a vessel, the fat globules, being lighter than the other ingredients, rise to the surface of the liquid. In so rising they carry with them a portion of the other materials of the milk, and the mixture is called cream. While the composition of the cream varies, especially in its fat content, depending upon the method of separation, the following figures give an idea of an average sample of Cooley cream : —

Cream.	Per Cent.
Water, ...	72.90
Fat, ...	18.00
Albuminoids, ...	3.90
Milk sugar, ...	4.50
Ash, ...	.69

Methods of Separating Cream.

The three methods of separating cream from the milk may be defined as the shallow pan, deep setting, and separator systems.

The quantity of cream for consumption is not seriously affected by either of these methods of separation, so that relative economy depends upon the completeness and cost of separation.

In the separation of cream by force of gravity, there is a great loss of fat, and a longer time required, than when the centrifugal process is employed. According to Wing, the conditions of the milk that affect the creaming by the gravity process are first, the size of the fat globules; second, the amount of solids not fat in the milk; third, the character of the solids not fat; and fourth, the temperature of the milk.

The larger the fat globules, the more rapidly they separate from the milk. The size of the globules is dependent upon the breed and individuality of the cow, and upon the period of lactation. The amount of solids not fat affects the rising of the cream, because of the difference in specific gravity between the fat and the other ingredients. Solids not fat are heavier than water, and hence, the larger the amount of solids not fat, the more rapid one would expect the separation. The favorable effects of the solids not fat are, as a rule, however, more than offset by the character of the solids. The solids not fat are the casein, albumin, sugar and ash, and these in the order enumerated increase the viscosity of the milk. This increase in viscosity retards the separation of the fat to a greater degree than the increase in specific gravity tends to aid it. This increase in solids and viscosity takes place as the size of the fat globules are growing smaller, hence cows in an advanced stage of lactation produce milk which separates very slowly. Finally, a sudden chilling of the milk immediately after milking and keeping it at a temperature of 40° F. aids in a thorough separation of the cream.

Shallow Setting. — This old method has long been discarded by those who understand modern dairy principles. Its chief objection is its inconvenience, and the difficulty of

securing a complete separation. As a rule, this method leaves about 20 per cent of the fat in the milk. Milk testing 5 per cent would have 1 per cent of fat left in the skim-milk. If the process is carried out carefully, it is sometimes possible to skim as low as .5 of 1 per cent.

Deep Setting.—Some twenty-five or thirty years ago it was discovered that if milk was set in vessels when first drawn, and rapidly cooled at a temperature of 40° F., and kept at that temperature for twenty-four hours, the depth of the milk could be increased from four to twenty inches, and the separation made much more complete in a shorter time. Several so-called deep-setting systems have been upon the market, the more common one in Massachusetts being the Cooley process. This method hardly needs an extended description, it having been in very general use among Massachusetts dairymen. The tin cans employed are some twenty inches deep by nine inches in diameter, covered with tight-fitting covers, and hold eighteen quarts each. The milk is placed in the cans as soon as drawn, and the latter immediately completely immersed in water at 40° F. and kept there for twenty-four hours. If the milk is from cows that have recently freshened, there will not be much over .2 of 1 per cent of fat in the skim-milk. As cows become advanced in the period of lactation, the skim-milk frequently contains from .5 of 1 per cent to as high as 1 per cent of fat. Taking the year through, the skim-milk from a herd of cows is liable to contain fully .5 per cent to 1 per cent of fat. If the milk from a cow producing 6,000 pounds yearly with 4 per cent fat be set by this system, there is liable to be a loss of some 24 pounds or more of butter in the skim-milk. The cream obtained by the deep setting is thin, and varies quite widely in the amount of butter fat it contains, the extremes being from 12 to 24 per cent, with a probable average of 17 to 18 per cent. The disadvantages of this method, aside from the loss of fat, consist in the length of time required to secure a separation, and the amount of ice consumed. The chief advantage consists in the fact that no power is required, the milk being poured from the milk pail directly into the cans and allowed to remain in the water until the skim-milk is drawn off.

Separation by Dilution. — This method has been practised to an extent by those who did not desire to employ ice in large quantities. Deep cans similar to Cooley cans were employed, and the milk diluted with one-half or an equal volume of water, and allowed to stand at ordinary temperature for twelve hours. The skim-milk resulting was found to contain from .70 of 1 per cent to 1 per cent of fat.

Of late, several so-called "dilution or gravity separators" have been placed upon the market, with the claim that a very thorough separation of fat can be secured. These have been known as Wheeler's Gravity Cream Separator, made by the Gravity Cream Separator Company, Mexico, N. Y., Hunt's Improved Ventilated Cream Separator, made by the Hunt Manufacturing Company, Cato, N. Y., and the Aquatic Cream Separator, made by the Aquatic Cream Separator Company, Watertown, N. Y. "The machines are simply tin cans fitted with upper and lower scale glasses, a faucet at the bottom through which the milk is drawn, and a wire ring at the top for holding a strainer cloth or cloth cover." "The Aquatic separator differs from the others in the fact that the can is of considerably larger diameter and is provided with another smaller can, intended to be filled with ice and inserted in the large can as a cooler." The milk is mixed with an equal quantity of water and set at ordinary temperature. The circular issued by the Wheeler Company states that "any time after two or three hours, or between milkings, you can draw off the milk and cream."

The Cornell Experiment Station Bulletin 151 gives considerable information concerning these "machines," from which the above is taken. The results of the investigation of the merits of this method of separation, as given in the bulletin, are as follows: —

"Gravity or dilution separators are merely tin cans in which the separation of cream by gravity process is claimed to be aided by dilution with water.

"Under ordinary conditions the dilution is of no benefit. It may be of some use when the milk is all from 'stripper' cows, or when the temperature of melting ice cannot be secured. (C. U. Agr. Exp. Sta. Bull. 39.)

"These cans are not 'separators' in the universally ac-

cepted sense of that term and cannot rank in efficiency with them.

“They are even less efficient than the best forms of deep-setting systems, such as the Cooley creamer.

“They are no more efficient than the old-fashioned shallow pan; but perhaps require rather less labor.

“In all probability they would give better results if used without dilution and immersed in as cold water as possible, preferably ice water.”

Separator (Centrifugal) System.—In the removal of cream by the centrifugal machine, centrifugal force, generated in a rapidly revolving bowl, is used to take the place of the force of gravity. The fat, being lighter than the other milk ingredients, is thrown to the outer surface of the bowl, and a more thorough separation is obtained than by any other method. It is not the intention of the writer to explain in this connection the construction of any style of separator. These machines are coming into general use at present, and bid fair to take the place of the gravity method. Full description of their construction will be found in the explanatory circulars issued by the manufacturers, and in books on dairy subjects. Separators can be regulated so as to produce cream containing from 20 per cent to 50 per cent of butter fat. They have been so perfected that many can be relied upon, if properly manipulated, to skim to .1 of 1 per cent butter fat or less. This may be illustrated from the following table:—

Machines.	Per Cent Fat in Skim-milk.
Accumulator, ...	.11
Alexandria Jumbo, ...	.22
Columbia, ...	.12
Danish Weston, ...	.08
De Laval, ...	.09
Sharples, ...	.16
United States, ...	.12
Victoria, ...	.16

While the majority of separators can be made to do perfect work, there are variations in different machines of the same grade and manufacture, and these differences can only be detected by an actual examination of the skim-milk. The

purchasers should therefore purchase a machine with a manufacturer's guarantee of efficiency. So far as the writer is aware, there is no *best* separator. "Other things being equal, that separator is best that will *skim the cleanest at the lowest temperature, and with the least number of revolutions per minute,*" with the least amount of power. The two separators in most general use in New England are the De Laval and the Improved United States. The Sharples separator is also used to some extent. Both the De Laval and the Improved United States skim very close. The De Laval requires rather less power to run than many machines. As is well known, there are both hand and power separators. The writer is not particularly inclined towards hand machines, because of the labor involved in turning, and would advise those who are purchasing to secure some sort of power, either horse, water motor, gas engine, or steam if more convenient. The separator aids naturally in removing impurities from the milk, and milk is often run through the separator for this purpose alone, and then remixed. These impurities form in what is known as the separator slime. The advantages of the separator, briefly stated, are that the milk can be skimmed as soon as drawn, rapidity of skimming, clean skimming, with thin or thick cream, as desired. Separator skim-milk will not keep sweet as long as skim-milk obtained by the deep-setting process, unless it is cooled and kept at a low temperature at once after coming from the separator. It naturally looks rather thinner than ordinary skim-milk, because of the more thorough removal of fat. The writer believes the separator to be the most economical method of securing milk fat, especially when the producer has a dairy of fifteen or more cows.

PASTEURIZATION OF MILK AND CREAM.

By pasteurization is meant the heating of milk or cream up to a temperature of 155° F., holding it at that temperature from twenty to thirty minutes, and then cooling it rapidly to 50° F. The term pasteurization is derived from the celebrated French chemist, Pasteur, who first suggested the idea for the purpose of increasing the keeping of beer and wine.

The object of holding the milk or cream at this temperature is to destroy or render harmless for a considerable time the various bacteria contained in the milk, thus preserving it from decomposition. Heating at this temperature, while it kills or renders harmless the bacteria, does not destroy the spores. This destruction of bacteria increases the keeping quality of the milk or cream by several days.

If it is desired to ripen cream for butter making by any special ferment, the pasteurization of the cream, even for a few minutes, so overpowers or partially destroys the ordinary bacteria of the cream, that the special bacteria introduced have opportunity to become thoroughly developed.

Sterilization of milk or cream means the heating of it to boiling or even above the boiling point by aid of pressure. This not only destroys the bacteria, but the spores as well, although for a complete destruction of the spores more than one heating is necessary. The so-called Dahl process for making perfectly sterilized milk consists in heating the milk to 158° F. for three-quarters of an hour, then cooling to 104° F. for the same time, then heating to 175° F., and finally cooling and placing in sterilized vessels. The object of heating to 104° F. and holding at this temperature for three-quarters of an hour is to allow the spores, which were not destroyed by the first heating, to grow. The second heating destroys them. Milk thus treated has been kept perfectly sweet for a long time.

Details to be observed in Pasteurizing.—The milk introduced into the pasteurizing apparatus should be heated as rapidly as possible to 150° or 155° F. and held at that temperature from twenty to thirty minutes. During the heating it should be constantly stirred, to prevent burning on the sides of the vessel. At the expiration of the time, the milk should be rapidly cooled to 50° or 60° F. and then drawn off into sterilized bottles or cans, the covers put on at once, and placed in ice water. The bottles can be cleaned by the use of some form of bottle cleaner now on the market. This is to be preferred to the use of chemicals. After washing they should be placed in boiling water for ten minutes, and then placed upon racks, mouths downward, to drain. A better way is to use a sterilizing oven (a jacketed oven surrounded

by steam). The bottles can be removed, while warm, from the oven, and immediately filled.

Milk or cream thus treated will have but a slight cooked taste, and this will almost entirely disappear in cooling. Its chemical composition is not changed, nor its digestibility decreased. It is claimed, on good authority, that pasteurized cream will make a butter superior to that from unheated cream. This is probably due to the fact that pasteurization destroys obnoxious germs, and permits, by inoculation, the development of those favorable to a good quality of butter. Pasteurization causes both milk and cream to become thinner than the normal products, with same percentage of fat. This diminished body is due to the fact that the heat causes the fat globules, which are in clusters or clots, to break apart and become more evenly divided throughout the milk. Babcock and Russell have overcome this by the addition of so-called *viscogen* to the cream.*

Viscogen is prepared by taking two and one-half parts by weight of cane sugar and dissolving it in five parts by weight of water. One part by weight of quick lime is gradually slaked in three parts by weight of water. This milk of lime should be slowly poured through a strainer into the sugar solution, frequently stirred, allowed to settle for several hours, and the clear liquid poured or siphoned off and preserved in well-stoppered bottles. One part of this solution is slowly added, with constant stirring, to one hundred and fifty parts of cream. (See Bulletin 54 for further details.) While the addition of this material might be considered as contrary to law in case of milk, it hardly seems possible that there could be any objection to its use in cream. It certainly cannot be considered as objectionable from a sanitary stand-point. In case there should be objections raised against its use, cream thus treated could be designated by some particular brand, such as visco-cream, or the like.

* Bull. 54, Wisconsin Experiment Station.

PASTEURIZATION APPARATUS.

Milk or cream can be pasteurized by putting into cans of about the shape and size of those employed in the Cooley process, and placing the cans in a tin or copper tank filled with water. The water should reach a temperature of 165° F. or thereabouts, and the milk, after the temperature has reached 155° F., should be held there for the requisite time and constantly stirred. After the completion of the heating the cans should be brought into water containing broken ice, and the milk stirred and cooled.

In case it is desired to dispose of the milk or cream in bottles it should be drawn into the bottles at once after cooling, and the bottles placed in ice water. It is necessary that the temperature of the milk should be kept low, and that it be thoroughly covered, to prevent any dust particles from gaining access to it. It is not expected that as good results can be obtained by this method as when special pasteurizing machines are employed, and one who intends pasteurizing to any extent will find it necessary to fit his dairy with special pasteurizing apparatus.

The pasteurizing of milk or cream for butter making is practised to a slight extent in the United States. Nearly all of the milk that is made into butter in Denmark is first pasteurized, and, it is claimed, with very beneficial results. It is quite probable that this method of treating milk and cream for butter will come into more general use in the United States. There are a great many foreign machines made to accomplish this work, and many of them, it is said, give quite satisfactory results. A number of machines have also been constructed in this country. The one manufactured by A. H. Reed of Philadelphia has been said to give good results. It consists of a combined pasteurizer and separator. The milk is passed through the pasteurizer in a continuous flow, and is separated while hot. The machine has a capacity of 2,500 pounds per hour. Pasteurizing machines are also on the market for the preparation of milk and cream to be sold as such. One made by Cornish, Curtis & Green, of Fort Atkinson, Wis., has been spoken of favorably. Mosely & Stoddard Manufacturing Company of Rutland,

Vt., manufacture a machine which is in use by a number of large milk and cream dealers, who claim to be well pleased with its work. Special circulars are issued, explaining the construction and operation of these machines. Those interested in this subject, as well as in the whole subject of milk and cream production, are referred to special modern publications given at the end of this article.

MARKETING OF MILK AND CREAM.

Milk and cream are now being sold to a considerable extent in glass jars in place of tin cans. Glass certainly presents a more attractive appearance than tin. Each purchaser secures an even quality of milk, as the milk is mixed before the jars are filled, and not again disturbed till opened by the consumer. The cream can also be seen through the glass, and the purchaser feels that he has opportunity to see just what he is buying. It is of the utmost importance, if this method is to be successful, *that the jars be kept perfectly clean.*

It is hoped that the time is rapidly approaching when market milk and cream will be sold on a guarantee of quality. As has been already stated, milk will vary in composition from 11.5 to 15 per cent of total solids, and from 3 to 5.5 per cent of fat. Cream contains from 15 to 50 per cent of fat. Milk and cream should not only be properly cared for, and placed on the market in an attractive condition, but they should contain a guarantee of total solids and fat. There should be a price for 3 per cent milk and for 4 and 5 per cent milk, as well as for 20, 30 or 40 per cent cream. This is a matter of justice to the honest producer, as well as to the consumer. It is an encouraging sign to note that some of our more representative dairymen are beginning to carry out this idea.

MODERN BOOKS OF REFERENCE IN DAIRYING.

"Milk and its Products," by H. H. Wing, published by the MacMillan Company, New York.

"American Dairying," by H. B. Gurler, published by Breeder's Gazette Print, Chicago.

"Modern Dairy Practice," by Grotenfelt & Woll; published by John Wiley & Son, New York.

“Dairy Bacteriology,” by H. L. Russell, Madison, Wis., published by the author.

“The Pasteurization of Milk,” by J. H. Monrad, Winnetka, Ill., published by the author.

Year Book, Department of Agriculture, 1894, article on “The Pasteurization and Sterilization of Milk,” by E. A. DeScheweinitz.

This last book can be had free upon application to Department of Agriculture, Washington, D. C. The other books cost from 50 cents to \$1.00 each, and can be obtained through the publishers, or quite possibly through the agricultural papers.

STABLE DISINFECTION.

BY PROF. JAS. B. PAIGE, VETERINARIAN TO THE BOARD.

The most satisfactory and least expensive method of dealing with the diseases of domestic animals is to prevent them. In many instances this may be done to advantage, with but little trouble on the part of the owner.

The prevention of disease is more under control of the one having immediate care of animals than the veterinarian, who is only consulted, or directs as to the best methods of prevention. This applies to such disorders as arise from improper feeding or watering, over-working, not allowing sufficient exercise to keep in a healthy condition; to disease, occurring in connection with keeping animals under unsanitary conditions; for example, keeping animals closely confined in stables where there is defective drainage, or where there is a deficiency of pure air or insufficient light, — in general, where conditions are such as tend to weaken the constitution and open the way for the easy development of disease.

The scientific study of animal pathology and bacteriology during recent years has demonstrated that a large proportion of the animal diseases is caused by the introduction into the body of microscopically minute particles of living vegetable matter, whose growth in the body fluids or tissues, or the action of whose product of growth upon the different organs, gives rise to this or that disease.

This applies to most disorders of a contagious or infectious nature. The organisms causing the diseases are given off from the bodies of the affected animals, and are brought in contact, through the medium of the air or by some similar means, with the bodies of the healthy animals.

We know that certain of these contagious diseases have a specific cause in the form of an organism possessing peculiar

characteristics by which we are able by bacteriological methods to detect its identity. Under all conditions this organism retains its characteristics, and in all cases gives rise to the same disease.

For example, the organism of tuberculosis always produces this particular disease, and by no means whatever can it be so altered that it may produce another, such as glanders. When liberated from the body of a diseased animal, the germs may under certain natural conditions retain their vitality for a very long time, in some instances even months and years. Then, if after this long time they are again brought under favorable conditions inside the body of a susceptible animal, they may develop and produce disease.

The object of disinfection is the destruction of these disease-producing organisms and parasites, as well as the cleansing of the stable of other objectionable impurities existing in the form of living matter which may gain access to the milk, impairing its keeping qualities, imparting to it an objectionable odor, color or flavor.

The fact that it is impossible for one of the contagious diseases to develop independently of the particular organism which can produce it, and that the organism can only originate in an animal suffering from the disease, shows the necessity of destroying or rendering it inactive before it can gain access into the healthy individual.

Disinfection and thorough cleaning, as viewed from the bacteriologist's point of view, are essentially the same. Nature has provided us with one of the most powerful disinfectants we possess, namely, *sunlight*. In order to avail ourselves of it, we must so construct our barns that it may act to the best advantage. Active, virulent cultures of the germs of tuberculosis, glanders, typhoid fever or diphtheria are rendered perfectly harmless if exposed to the action of direct sunlight for a few hours. The same is true where the germs are given off from the body of a diseased individual, provided they are not protected from the direct action of the light by being enclosed in other matter, such as mucus, pus, feces, etc. Diffuse daylight has a disinfecting action, but is much less powerful than direct sunlight. Where one or two hours' exposure to the action of direct sunlight would suffice

to destroy disease-producing organisms, several days or weeks might be required to accomplish the same thing by diffuse light.

Sunlight not only acts beneficially in the stable by destroying objectionable micro-organisms that may be present, but it has a beneficial effect upon the animals kept in such a stable. Occasionally we see stables arranged in such a manner that the animals are placed upon the shady north side, while the sunny south side is used for storage purposes. The action of sunlight upon the animals is to increase the red blood corpuscles and to stimulate and strengthen all the organs of the body. Well-lighted stables are invariably much dryer than dark ones. This is a distinct advantage in favor of keeping the stable clean and the animals in it free from disease. The disease-producing microbes find much more favorable conditions for retention of their vitality or growth and multiplication where the atmosphere contains large quantities of moisture, rather than when it is dry. Ordinary drying is, in fact, all that is necessary to destroy some of the most dangerous germs. This does not apply equally to all; while Asiatic cholera germs are quickly killed by drying, those of tuberculosis are only slightly affected by it.

Animals kept in dark, damp, underground stables are much more subject to disease than those kept under better sanitary conditions. This applies to all domestic animals, but more especially to horses, which soon become hidebound, rough-haired, and suffer from coughs, colds, etc.

Tuberculosis in cattle, glanders and influenza in horses, hog cholera and swine plague in swine, and similar diseases, appear more quickly, spread more rapidly and are much more fatal among animals kept in dark, damp, underground stables than among those kept in light, dry, airy barns. Simple wounds often become unhealthy and gangrenous, leading to a fatal termination, among animals under unsanitary conditions, whereas, upon those under good hygienic surroundings, they heal quickly. In the first instance they become quickly infected with the organism producing supuration, gangrene and blood poisoning, while in the second instance no such infection occurs.

Heat is one of the best disinfectants which it is possible to employ. All life, both animal and vegetable, is quickly destroyed when subjected to the action of a high temperature. It may be employed in one of several forms;—a flame, dry heat or moist heat.

When it is advisable to absolutely destroy material contaminated with infectious matter, there is no safer way to dispose of it than by burning. Wood work, such as mangers, hay racks, stall partitions, floor, etc., that may have become thoroughly infected with such material as the nasal discharge from glandered horses, is best disposed of by burning. The bodies of animals dying of infectious diseases which may be transmitted to other animals by eating the flesh or by contact with the offal or discharges from the dead body, are safely gotten rid of by cremation. Burning is preferable to burying, as certain organisms find in soil favorable conditions for their preservation and multiplication.

Fire may be used to disinfect iron, stone or brick work, or other materials of a non-inflammable nature, by passing a flame over them. An ordinary gas or Bunsen burner attached to the gas fixture by means of a flexible rubber tube affords a convenient means of securing a flame for disinfecting purposes.

Dry heat is applicable to the disinfection of certain objects that cannot be subjected to the action of the flame or to moist heat. Brushes, curry combs, blankets and similar objects that may have been in contact with animals suffering from contagious disease are sterilized by baking. Special apparatus for this purpose has been invented and manufactured for use in quarantine stations, hospitals, etc. For all practical purposes on the farm an ordinary stove oven is all that is required. The article to be disinfected should be put into the oven in as loose a condition as possible, in order that the heat may penetrate to every part. Twenty minutes' exposure at a temperature of 300° F. is sufficient to destroy any harmful organism that may be present. If no thermometer is at hand by which the temperature may be taken, a small quantity of ordinary cotton batting may be used. Lay it out loosely on the article to be disinfected; when the temperature has risen sufficiently high to give a slightly brownish

color to the cotton, one may be assured that disinfection is completed.

Moist heat in the form of boiling water or steam may be used as a disinfectant for those parts of a stable or those objects about it that cannot, owing to their nature, be treated by fire or dry heat.

Washing thoroughly with boiling water is very effective as a means of disinfection. Warm water in which the hands can be borne cannot be relied upon. To do the work, it must be quite near the boiling point, and requires to be applied with a mop or a broom. Live steam applied directly from a steam-pipe or hose is much more active than boiling water. It acts very energetically and quickly. To steam walls, floors, mangers, etc., is a sure and satisfactory way of disinfecting them. Pails, blankets, tools, etc., may be either boiled or steamed by immersing them in water or by placing them over boiling water in a tightly covered kettle. An exposure from twenty to thirty minutes is sufficient time to disinfect, provided the object is of such size or texture that the steam or water can readily come in contact with every portion during the greater part of the time.

There are numerous chemical substances that destroy infectious matter. In certain cases it may be advisable, on account of greater convenience or other circumstances, to use one or more of these, in place of those means already mentioned. Among the large number of such substances are carbolic acid or similar preparations, corrosive sublimate, chloride of lime, sulphur fumes or chlorine gas.

Carbolic acid is a cheap, effective disinfectant, but, owing to its caustic nature, must be used with care, to avoid accidents. The strong acid brought in contact with the skin quickly destroys it. All solutions, whether weak or strong, taken internally in considerable quantities are irritating and poisonous.

Carbolic acid is sufficiently soluble in water so that a five per cent solution may be made. If more than one part of acid is added to twenty parts of water, the excess remains in suspension as pure acid. A five per cent watery solution is sufficiently strong to destroy most germs inside of one hour, provided the organisms are kept continually moist with it.

A solution of this strength is not caustic, but so irritating that with most persons it will at first cause tingling and later numbness of the hands or other parts of the body with which it may come in contact for any length of time. A five per cent watery solution may be used for the disinfection of walls, floors, mangers, harnesses, excrement, offal, etc. For use upon floors and walls it may be applied economically by means of a pump; preferably such a one as is employed for spraying fruit trees. Thrown in a fine spray against the walls, it penetrates into all the cracks and crevices. There is little danger in using a five per cent solution about mangers or feed troughs if they are allowed to become thoroughly dry before being used.

Carbolic acid solutions are particularly effective for ridding stables, pig pens and hen houses of lice and other parasites. One part of acid and twenty or thirty parts linseed oil makes an excellent mixture for application to the skin of animals harboring lice or other animal or vegetable parasites.

For disinfecting soils, manure heaps or bodies of animals, stronger mixtures than five per cent solution may be used. Crude acid is suitable for all disinfecting purposes of buildings, but only the better grades should be applied to the bodies of living animals.

To increase the efficiency of carbolic acid as a disinfectant, some advise the use of sulphuric acid in combination with it. The United States Department of Agriculture a few years since recommended the use of the following mixture, and gave these directions for its preparation and use:—

Crude carbolic acid, one-half gallon; crude sulphuric acid, one-half gallon. It is not poisonous, but quite corrosive, and care should be taken to protect the eyes and hands from accidental splashing. These two substances should be mixed in tubs or glass vessels. The sulphuric acid is *very slowly* added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the acid in cold water while the sulphuric acid is being added. The resulting mixture is added to the water in the ratio of one to twenty. One gallon of mixed acids will thus furnish twenty gallons of a strongly disinfectant solution having a slightly milky appearance.

Creolin, lysol, disinfektol and other coal-tar products which closely resemble carbolic acid in their composition and action may be used for disinfection in place of the latter. While less caustic, irritating and poisonous, and possibly slightly more active as disinfectants, they are not so easily obtained as carbolic acid, and are for practical purposes but little if any better.

Corrosive sublimate (perchloride of mercury) is a very poisonous, caustic and corrosive chemical, and must in all cases be used with great caution, to avoid fatal results. It is the strongest disinfectant for practical use that we have. As small a quantity as one part to forty or fifty thousand parts of meat infusion will prevent the growth of bacteria in it. Stronger solutions are used for disinfecting purposes, one part to one thousand parts of water or one to five hundred parts of water being the strength of the mixture usually recommended. Approximately, sixty grains of sublimate to a gallon of water or one ounce to eight gallons make a solution of one to one thousand parts. It should always be mixed and kept in glass jars or wooden tubs, as it quickly corrodes metals. The mixture should be well stirred and allowed to stand for several hours, in order that the sublimate may become thoroughly dissolved.

Never allow it to remain uncovered, where it is accessible to man or animal.

It may be applied with mop or brush, or better with spraying apparatus, as advised for carbolic acid. When mixed with dirt, especially manure, it loses its strength in proportion to the amount of foreign substances present. For this reason all dirt should be removed from the walls as thoroughly as possible by washing and scraping before the sublimate is applied. Mangers, troughs, pails, etc., that have been treated with sublimate, should be carefully rinsed several times before being used again.

As carbolic acid, creolin and the other coal-tar products are less dangerous, it is better that they be used, unless the use of the sublimate can be entrusted to an intelligent and reliable man.

To destroy infectious matter in the air or in those parts of the stable that cannot be easily or thoroughly treated by

those disinfectants already mentioned we must employ an aerial disinfectant. As a precautionary measure to insure thoroughness it is frequently advisable to use an aerial disinfectant in conjunction with one of those previously discussed. Gaseous disinfectants will penetrate into cracks and corners that cannot be reached with liquid preparations.

The two gaseous disinfectants most available for ordinary use are *sulphur dioxide* and *chlorine*.

The former has been employed for cleansing purposes for many years, and experience has shown that it is a very effective destroyer of pathogenic organisms. To get satisfactory results, certain rules must be observed in its use. Experiment has demonstrated that it is much more effective in a moist atmosphere than in a dry one. It is therefore advisable to thoroughly sprinkle all walls, floors and ceilings of the space to be disinfected before the gas is generated. To do its work well the sulphur fumes must be present in the atmosphere to the extent of about three and one-half per cent. Three pounds of sulphur are required for each one thousand cubic feet of space. That the best results may be obtained, all doors, windows, ventilators and other openings should be tightly closed, that the gas may be kept confined for at least twelve hours. The disinfection will be better if retained for twenty-four hours.

To liberate the gas, it is only necessary to burn the sulphur. That form called "flowers of sulphur" is more convenient than rolls or sticks. The sulphur is placed in an iron kettle or upon a shovel, which may as a precaution against fire be set upon a brick surrounded by water in a wash tub or half barrel. A little alcohol may be sprinkled upon it and then lighted or a few live coals may be thrown upon it to start it burning. If the room to be disinfected is large it is better to burn sulphur in several places rather than in one, or one vessel containing it may be moved from place to place at frequent intervals. The disadvantage of the latter method is the difficulty of entering the room on account of the fumes, and again, in opening doors frequently more or less gas escapes.

Animals should not be returned to the stable until it has been thoroughly aired.

Chlorine gas is a powerful disinfectant and deodorizer. It is rather more active than sulphur fumes, and also much more irritating and corrosive. Like sulphur dioxide, chlorine destroys bacteria more readily in an atmosphere containing large quantities of moisture rather than in one free from it; hence the advisability of sprinkling the floors and walls before using. It requires about one per cent of chlorine gas in the atmosphere in order to be sure of disinfection. It is easily generated by adding hydrochloric or sulphuric acid to chloride of lime or ordinary bleaching powder. Five and one-half pounds of chloride of lime and an equal quantity of sixty per cent sulphuric acid mixed together will produce sufficient chlorine gas to disinfect one thousand cubic feet of space.

Care must be taken in using the sulphuric acid, as it is very caustic. It acts less violently when added to the lime if diluted by the addition of an equal quantity of water. If diluted, five and one-half pounds of acid must be used, the same as if no water were added. The acid and lime should be mixed either in earthen, glass or wooden vessels; ordinary stone jars are suitable for this purpose. Metals of all kinds are quickly destroyed by the acid.

The chlorine gas does not require as long a time to destroy germs as does sulphur dioxide; five or six hours are usually sufficient. The longer it acts, however, the more thorough the disinfection.

It is always to be borne in mind that sulphuric acid and chlorine are to be used with great caution, to prevent accidents. During fumigation all animals should be removed from the building, and should not be returned until it has been well aired.

In the work of disinfection it is all-important that it be done thoroughly. Everything which has come in contact with the diseased animals, including clothing, cleaning utensils, pails, and even the hands of the person attending the sick, should be carefully treated. Too great care cannot be exercised in this connection. The success of getting rid of contagious matter from a building depends wholly upon the thoroughness of disinfection, provided the source of contagion has been removed.

EIGHTH ANNUAL REPORT
OF THE
DAIRY BUREAU
OF THE
MASSACHUSETTS BOARD OF AGRICULTURE,

REQUIRED
UNDER CHAPTER 412, ACTS OF 1891.

JANUARY 15, 1899.

DAIRY BUREAU—1898-99.

D. A. HORTON, NORTHAMPTON, *Chairman.*

J. L. ELLSWORTH, WORCESTER.

C. D. RICHARDSON, WEST BROOKFIELD.

Executive Officer.

W. R. SESSIONS, *Secretary of the State Board of Agriculture.*

*Assistant to the Secretary and Acting Executive Officer, appointed by the
Governor.*

GEO. M. WHITAKER, BOSTON.

REPORT OF THE DAIRY BUREAU.

Massachusetts stands high among the States of the Union as a manufacturing State. Many of her towns and cities have a national reputation as manufacturing centres for various products, such as cotton cloth, boots and shoes, spectacles, watches, whips, etc. The census for 1895, just published, shows that the value of the manufacturing plants in the State aggregates \$325,000,000, cotton manufacturing leading, with \$92,000,000 invested; the value of the agricultural property of the State is \$220,000,000. So that, although Massachusetts is pre-eminently a manufacturing State, and as such is prominent among the States, it is two-thirds as much of an agricultural State as it is a manufacturing State, so far as investment in real estate, machinery, buildings, water power, etc., are concerned.

Of the agricultural products of the State, dairying leads. The census for 1895 gives the value of the dairy products of the State as follows : —

Butter,	.	.	.	.	.	.	.	\$1,506,638
Cheese,	.	.	.	.	.	.	.	11,661
Cream,	.	.	.	.	.	.	.	1,011,604
Milk, .	.	.	.	.	.	.	.	13,704,146
								\$16,234,049

Hay and fodder are second; but, as most of the hay and fodder grown in the State is fed to dairy animals, it is fair to add quite a proportion of the \$12,000,000 value of hay and fodder to the above \$16,000,000. In the cream furnished to creameries and in other ways there is a possible duplication of values, as the census enumerates each separate article in every step of manufacturing, because frequently the manufactured product of one industry is the raw material of another. But, making a reasonable deduction for duplications, and then adding a proper proportion of

the \$12,000,000 value of hay and fodder grown, we find that beyond question the dairy products of the State are more in value than one-half of all agricultural products, — \$53,000,000. If, then, dairying is the leading specialty in agriculture, and if agriculture in value of plant is two-thirds of the manufacturing industries of the State, we find that dairying is of much importance in Massachusetts. And it is fitting that legislation should pay particular attention to pure, honest, wholesome dairy products, in the interests of both consumer and producer.

The personnel of the Dairy Bureau suffered a change at the beginning of the year by the expiration of the term of office of Mr. George L. Clemence of Southbridge, delegate to the Board of Agriculture from the Worcester South Agricultural Society. Mr. C. D. Richardson of West Brookfield was elected to the State Board in his place, and appointed on the Dairy Bureau. The term of office of Mr. D. A. Horton, as one of the members at large of the Board of Agriculture, having expired, he was reappointed by the Governor, reappointed on the Bureau and re-elected chairman.

The actual executive work of the Bureau has continued under the supervision and direction of George M. Whitaker. The Bureau has employed during the year only two regular agents, Messrs. J. W. Stockwell and George F. Baldwin, who have been in our employ for several years. The place of the third, made vacant by resignation of Mr. Charles C. Scott, has not been filled, but temporary agents have been employed from time to time to do special work. Dr. Charles Harrington, the Boston milk inspector, and his staff, continue as agents of the Bureau, serving without expense to the State, in order that in an emergency their efficiency of action may be increased. The chemical work of the Bureau has been done by Dr. B. F. Davenport for the eastern part of the State, and by the Hatch Experiment Station for the western part.

The work of the Bureau during the past year has been conducted along the same general lines as heretofore, the principal difference being in paying increased attention to the milk supply.

STATISTICAL WORK.

The statistical report of our work has been as follows :—

Inspections of stores, wagons and railroad stations, for illegal	
keeping of imitation butter, ...	1,351
Samples taken of real or imitation butter, ...	230
Samples taken of milk, ...	901
Samples taken of cream, ...	6
Samples taken of cheese, ...	1
Samples taken of condensed milk, ...	2

The Bureau has had in court during the past year 60 cases, as follows :—

Having milk of less than standard quality in possession with intent to sell, ...	30
Having milk to which preservative had been added in possession with intent to sell, ...	9
Having an imitation of yellow butter in possession with intent to sell, ...	13
Serving oleomargarine in hotels and restaurants without giving notice, ...	3
Obstructing officers in the prosecution of their work, ...	5
	60

In addition to these, evidence has been secured in five other cases, complaints have been made and warrants issued, but the officers have been unable to find the defendants, who have left the vicinity if not the State. Four of these were imitation butter cases, and one for obstructing an officer.

Of the above 60 cases in court, in only one instance was the defendant acquitted and discharged. In that case he was charged with obstructing an officer who was engaged in getting samples.

IMITATION BUTTER.

The Bureau has enforced the laws regulating the sale of imitation butter as vigorously as usual, and along the same general lines. Stores are visited and samples taken or purchases made, suspicious “butter” wagons are overhauled and inspected, and various clues followed in such manner as the exigencies of each particular case seem to demand. Some-

times a line of investigation may be followed for several days with no reportable results in number of inspections made or samples taken. This part of our work is like all other kinds of detective work, and has a wholesome effect on would-be law-breakers far beyond the story told by any mere statistics.

During the year we have made 1,351 inspections of stores, wagons and railroad stations, and taken 230 samples. We have had 21 cases in court, and would have had 5 more could the parties have been found. Of the 21, we lost only 1. The charges were as follows:—

Violating anti-color law, ...	13
Violating hotel-restaurant law, ...	3
Obstructing an officer, ...	5
	21

During the past year one dealer in imitation butter has served a term in the house of correction in default of a fine.

Of the 13 violations of the anti-color law, above reported, the imitation product was sold as and for butter in several instances; but complaints were made for violating the anti-color law, for technical reasons of detail in connection with the trial of the cases. Evidence of more sales of the deceptive product when butter was called for would have been secured were not the agents so well known.

As we have previously reported, the open sale of imitation butter seems to have been practically suppressed. It is an exceptional case where a person can purchase it, to take away with him, in any store in the Commonwealth. Yet, in spite of this, considerable quantities are consumed within the Commonwealth, mostly sold under various subterfuges. Itinerant peddlers dispose of some, and stores that “take orders” still further evade the law, while in some instances officers in charge of public institutions are purchasers. The amount sold is very small, compared with what would be sold were there no laws. In most cases the ultimate consumer does not know what he is eating, and in many cases the purchaser is equally ignorant.

The principle on which these laws are based has been endorsed by the State and national courts, and by the Legis-

latures of many States. Thirty-three States in the Union now have laws restricting the sale of imitation butter, and in 28 the laws are similar to those of Massachusetts.

The decision of the national supreme court, favorable to the Massachusetts anti-color law, in the Plumley case, has been reaffirmed in cases from the States of Pennsylvania and New Hampshire. Pennsylvania absolutely prohibited the sale of oleomargarine, and New Hampshire permitted the sale only when colored pink. The supreme court decided that both of these laws are unconstitutional; but in making that decision it alludes to the Plumley case, which it reaffirms, and explains wherein the Pennsylvania case differs from the Massachusetts case. It says:—

The statute in that case [Plumley] prevented the sale of this substance in imitation of yellow butter produced from pure, unadulterated milk or cream of the same; and the statute contained a proviso that nothing therein should be “construed to prohibit the manufacture or sale of oleomargarine in a separate or distinct form, and in such manner as will advise the consumer of its real character, free from coloration or ingredients that cause it to look like butter.” This court held that a conviction under that statute for having sold an article known as oleomargarine, not produced from unadulterated milk or cream, but manufactured in imitation of yellow butter produced from pure, unadulterated milk or cream, was valid. Attention was called in the opinion to the fact that the statute did not prohibit the manufacture or sale of all oleomargarine, but only such as was colored in imitation of yellow butter produced from unadulterated milk or cream of such milk. If free from coloration or ingredient that caused it to look like butter, the right to sell it in a separate and distinct form, and in such manner as would advise the consumer of the real character, was neither restricted nor prohibited. The court held that under the statute the party was only forbidden to practise in such matters a fraud upon the general public; that the statute seeks to suppress false pretences and to promote fair dealings in the sale of an article of food; and that it compels the sale of oleomargarine for what it really is by preventing its sale for what it is not; that the term “commerce among the States” did not mean a recognition of a right to practise a fraud upon the public in the sale of an article, even if it had become the subject of trade in different parts of the country. It was said that the Constitution of the United States did not take from the States the power of

preventing deception and fraud in the sale within their respective limits of articles, in whatever State manufactured, and that that instrument did not secure to any one the privilege of committing a wrong against society.

It will thus be seen that the case was based entirely upon the theory of the right of a State to prevent deception and fraud in the sale of any article, and that it was the fraud and deception contained in selling the article for what it was not, and in selling it so that it should appear to be another and a different article, that this right of the State was upheld.

Yet, in spite of this indorsement of the principle of our Massachusetts laws, they are sometimes criticised by persons who do not understand their full force and the facts which lead up to them. As is usual in such cases, the criticisms are superficially plausible, but fail to get at the real meat of the case. These laws are in the interests of producers, consumers and dealers in dairy products. They were enacted to promote honest dealing, and have proved very effective. A mixture of tallow and lard undoubtedly contains — as has been alleged — almost as many units of fuel-food value as does butter. If sold honestly, the compound would be of service to the world, — though relatively it is less digestible than butter, for the reason that butter contains aromatic principles which enhance digestion, and melts at a lower temperature than does the above-named mixture. Butter is the only animal fat which nature furnishes for use as human food in its raw state. But the principal argument for these laws rests more on the need of suppressing commercial dishonesty than on questions of relative digestibility. Could mixtures of tallow and lard be sold for what they are, the health question would not be of great importance; but when these mixtures are sold with the color, form of package, style of advertising and nomenclature of the dairy, the transaction is tainted with deception; honest producers, dealers and also consumers are injured. Oftentimes the price asked depends upon the perfection of the imitation, which increases the injury to the consumer. When an article which could be sold at a good profit at 12 to 15 cents per pound is sold at 20 to 22 cents because it is a good imitation of a 25-cent article, the nature of the business is readily seen. The temptation

for more than an ordinary profit is at the root of much of the traffic in this article. The principles of this class of laws have been frequently reaffirmed during the past few years in trade-mark cases, in which the courts have invariably pronounced against deceptive imitations.

As evidence of the deceptive way in which these goods are sold, we have noticed in a newspaper published in Rhode Island, where there are no laws restricting the sale of oleo-margarine, an advertisement, in the shape of a reading notice, like the following: "Vermont butterine for sale in ten-pound tubs at Smith's." We submit to any impartial and fair-minded person that such is hardly a candid way of advertising a mixture of tallow and lard, compounded in the State of Rhode Island. In this connection we would call attention to a decision of the United States circuit court, southern district of New York, Aug. 6, 1898, in the case of *Collinsplat v. Finlayson*, in which the court said: "The false use of a geographical name will not be allowed in the federal courts, when it is used to promote unfair competition and induce the sale of spurious goods." The same session of the court decided that "when an article sold is inferior and spurious, and the package sufficiently resembles the complainant's to make it apparent that the design was to deceive the consuming public, an injunction will be granted."

STANDARD MILK.

As stated in the introduction, we have given more attention to enforcing the milk laws this year than ever before. We have introduced a feature which has enabled us to do thorough work, particularly when at some distance from a chemist, in hot weather. Our agents take a portable Babcock milk tester to the town in which they are going to work, and make a preliminary test of every sample which they take, passing everything which has 3.75 or 3 per cent of fat, as the statute may be 12 or 13 per cent of total solids. Milks having less than this amount of fat are reserved for full chemical analysis, and, as a large proportion of all milk is up to or above this figure, a comparatively small number of samples is submitted to chemical analysis.

Of the 30 cases that we have had in court this year, out of 901 samples taken, the following are the analyses : —

Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.
—	11.49	2.30	11.42	2.10	11.22
2.70	10.97	2.60	11.66	2.76	10.80
2.68	11.53	2.14	10.66	2.00	11.62
2.00	11.74	2.90	11.34	1.66	11.16
.69	2.45	2.86	11.36	.20	9.35
2.56	11.46	2.60	11.44	3.28	11.45
2.20	8.46	2.98	11.48	2.90	10.74
2.24	9.50	2.60	11.60	2.24	11.08
1.56	10.10	2.50	11.72	1.52	10.88
1.80	10.98	2.50	11.60	1.80	10.10
2.00	10.80	2.18	11.00		

These cases were from Malden, Springfield, Chelsea, Lawrence, Revere, Everett and Holyoke.

It will be seen that this list contains a record breaker for poor cases. We do not believe that in the history of milk adulteration a sample as low as 2.45 per cent of total solids has ever been found before; 9.35 is also very low. It will be noticed that the highest sample of milk on which a case was maintained contained 11.74 per cent of total solids, of which 2 per cent was fat. Although the total solids in this case were close to the standard, the fat was only two-thirds of the proper amount. In the sample testing 2.50 per cent of fat and 11.72 total solids the case was prosecuted because the defendant was under suspicion of adulterating whole milk with skim-milk. Though conviction was secured, the case was put on file by the judge without imposing a fine, because the milk was so near to the standard.

Many persons who are not familiar with court practice think that a law establishing a milk standard and providing for its enforcement operates like a delicate machine, adjusted to cut with accurate precision upon a certain line, in which a blade falls without a particle of variation, so as to sever everything outside the gauge to which the machine is set. This, however, is not the way that criminal laws are enforced. Not every man who staggers is brought into court for being drunk; the case must be sufficiently strong, and the violation of law of sufficient magnitude, to make it prob-

able that the judge or jury will be convinced beyond a reasonable doubt that the defendant is guilty. Consequently, in the prosecution of milk laws some latitude from the statute standard must be allowed, and milk that comes within from one-half to three-quarters of one per cent of the standard is usually passed as being all right. Those who argue against a 13 per cent standard as being too high should remember that, for purposes of enforcing the law, milk of 12.5 per cent solids will pass as standard milk, and that, were the standard reduced to 12 per cent, it would let in milk of 11.5 per cent. Now, as the average milk of average cows when mixed contains 13 per cent of total solids, is it for the interest of the majority of producers to admit competition with milk of a lower grade? We recognize the fact that a minority of cows produce milk of 10 and 11 per cent solids; and we admit that there is a seeming hardship in saying that the pure, wholesome product of a healthy animal should be declared unmerchantable. But that is not the case. If owners of cows producing low-grade milk came to the Legislature asking permission to sell such milk at a low price, it would be difficult to find arguments against the proposition; but these people ordinarily ask that their low-grade milk shall be considered as standard milk, and sold at the regular price. Milk below the standard can now be sold if it is labelled skim-milk. The can may, in addition, contain a guarantee that the milk is the pure, natural product of a healthy cow. But we cannot conceive of any reason why the producer of such milk should be allowed to compete with producers of better milk, or to sell 10 or 11 pounds of food to producers who cannot protect themselves, and assume that they are buying an average article, to wit, 13 pounds.

We also desire to emphasize a point which we believe is many times overlooked,—that the laws of Massachusetts have made two entirely separate and distinct offences: one is the selling of “adulterated milk,” the other is the sale of milk “not of standard quality.” Though the fines are the same for both offences, there is a certain amount of moral turpitude and popular stigma attached to the selling of an adulterated product, which does not necessarily attach to the sale of a product which may be pure, but which is not of

standard quality. Yet newspaper accounts of trials and in some cases official reports inadvertently allude to adulterated milk, when milk not of standard quality is meant.

Vermont, like Massachusetts, prohibits the sale of milk not of good standard quality. The Maine law prescribes that, when milk is found of less than the prescribed standard, "it shall be deemed *prima facie* evidence that said milk has been watered." New Hampshire has a similar law. The Rhode Island law provides that, when milk is found having less than a certain per cent of solids, "it shall be deemed, for the purposes of said sections, to be adulterated."

These milk laws are sometimes criticised on account of the danger under which the farmer and the peddler labor in carrying on their business, the charge being made that an unseen sword dangles over their heads, held by a thread, liable at any moment to fall upon them. This is an exaggerated statement of the case. There is very slight chance of any honest producer or dealer getting into trouble through selling honest milk of less than standard quality. Average mixed milk contains 13 per cent of milk solids, and the quality of herd milk is quite uniform. It is only a small minority of individual cows that produce milk of less than 13 per cent solids, and even the mixed milk from grades of these cows is usually very near to the standard. But during five months of the year the standard is 12 per cent instead of 13, so that during five-twelfths of the time the standard is one per cent below the average quality of milk. Further than that, the practical details in enforcing the milk laws, as we have said, allow a latitude of from one-half to three-fourths of one per cent. The chances of trouble are still further reduced by increasing knowledge of the science of milk production. The causes of variation in the quality of milk are better known than ever before. It is now well established that there are no great mysteries or sudden fluctuations in the quality of herd milk, that feed has comparatively little to do with it, and that almost everything depends upon the individuality of the animals. If the mixed milk of a herd is not of average quality, — a fact which is of very rare occurrence, — it is because there are too many animals in the herd which are producing milk of less than standard quality.

With the use of the Babcock milk tester the producer can keep track of the quality of the milk he is selling, and be absolutely sure of it. It is interesting to note that our enforcement of the law in Holyoke has led to the purchase of a number of these testers by milk dealers and others, who propose to keep thoroughly informed as to the quality of the milk which they sell.

PRESERVATIVES IN MILK.

During the past year formaldehyde in its commercial solution of formaline has come into use in the State as a preservative of milk. Dr. Henry Leffman, a member of the Society of Public Analysts of Philadelphia, in the report of the Pennsylvania department of agriculture, says: "Formaldehyde is one of the newest preservatives, and gives promise of being the preferred one. Formaldehyde has a decidedly germicidal action, and, in addition, possesses the power of rendering nitrogeaneous matters insoluble and more or less indigestible." The enforcement of the law in years past has been so vigilant as to drive boracic acid, salicylic acid and the older preservatives out of the market, and it has been somewhat rare to find milk adulterated with them; but the discovery of the germicidal properties of formaldehyde has led to the pushing of various preservatives having that as a basis. One of these has been advertised considerably in Massachusetts as "Freezine." The advertisement of it says:—

The souring of milk or cream is due to the action of minute organisms known as bacteria. We have been experimenting with these bacteria in our laboratory for years, and have been rewarded by discovering a gas which, when dissolved in a liquid, has the same effect on bacteria that freezing them does, and makes them harmless. This gas has no bad effects on milk or cream, in fact, a chemist could not find any trace of it if the milk were analyzed, because the gas evaporates after it has done its work. . . . The advantages which we claim for "Freezine" are: the manner in which it affects the bacteria and preserves the milk and cream; and that it cannot be detected when used, as it does not change or affect the appearance, color or taste of milk or cream. "Freezine" is perfectly harmless, and is not injurious to the human

system, as it freezes the bacteria and evaporates quickly, leaving the milk in a perfectly wholesome condition. It is much cheaper to use "Freezine" than ice.

An "Anti-Sour" has been sold in much the same way.

These statements are so plausible that some milkmen have been led into purchasing the article; but a chemist *can* detect it, and in every case where we have found it convictions have ensued, nine in all.

In one respect the advertisement tells the truth, and that is, in a clause in which the substance is recommended for cleaning, sweetening and purifying milk cans and bottles. The effect of formaline in destroying bacteria is such as to make it valuable for this purpose, and it is used to a considerable extent in cleansing creameries and cheese factories. It is stated that in parts of Europe formaline is used to remove danger of disease germs in rooms where milk is kept for the city trade. It is also used as a spray in cheese rooms, to prevent mold on cheese. But we cannot recommend it as an article of food. Whether it is an unsafe substance to take into the human stomach is not yet proven; that is, there is as yet no judicial evidence that any person has actually suffered any ill effects from using food preserved with formaline, although a report in a western paper of the trial of a milkman in Kansas City for using formaldehyde states that the compound is supposed to have caused the serious illness of several persons, and the city chemist testified that the substance was poisonous.

The consensus of the best opinion, however, has been and is against chemical preservatives; though boracic acid and other substances may be harmless in minute quantities, the general use of them is condemned. It is possible, however, that this ground will have to be re-argued, on account of the growing popularity of formaline.

Dr. J. A. Miller, one of the chemists of the New York department of agriculture, says: —

It is not at all improbable that the use of formaline, not alone for the preservation of milk, but of other food stuffs as well, will soon become a wide one; and it therefore seems to me to be a

wise and prudent plan to undertake a careful and thorough investigation of the effects of formaline upon animal economy.

But a food preservative like this should be presumed guilty till proved innocent. We should not take chances in dosing the human system; what prevents bacterial action may impede digestion. Formaline is known to harden caseine; why, then, is the caseine not rendered less digestible?

Henry H. Wing, assistant professor of dairy husbandry in Cornell University, in a treatise upon the nature and qualities of milk and its products, says:—

A large number of chemical agents are more or less destructive to germ life. Many of them are so violent in their action as to destroy the milk, as well as the germs; but there are many which are destructive to germ life, with no effect upon the composition, odor or flavor of the milk. But all of these, without exception, are more or less injurious to the human system, particularly if they are used continuously, even though only in small quantities. Of the compounds which may be used for this purpose, formalin, salicylic and boracic acids and their derivatives are undoubtedly the least injurious, but their use is not to be recommended under any circumstances.

From “The principles of modern dairy practice from a bacteriological point of view,” by Gosta Grotenfelt, edited by F. W. Woll, assistant professor of agricultural chemistry, University of Wisconsin, we quote:—

The indiscriminate use of preservatives in food articles ought to be prohibited by law; this is especially urgent in case of such articles as milk and other dairy products, which in a large measure enter into the nutrition of children and convalescents. Most European countries long ago prohibited the addition of salicylic and boracic acid and other antiseptics in food, *e.g.*, Germany. Holland, France, Austria, Spain, Italy, etc. Mr. Hehner, the president of the Society of Public Analysts of England, in the November, 1890, meeting of the society, read a paper on food preservatives, in which he forcibly sums up the question in the following paragraph:—

“We should work for the entire prohibition of all kinds of preservatives. It is time that we went back to natural food. I object to being physicked indiscriminately by persons not qualified to administer medicine whilst I am in health. I object still

more when I am ill. I object still more strongly to have my children physicked in their milk or their bread and butter. It is no consolation to me to know that the physic is not immediately fatal or not even violently injurious. The practice is utterly unjustifiable, except from the point of view of a dealer who wants to make an extra profit, who wants to palm off a stale or ill-prepared article upon the public."

C. M. Aikman, M.A., D.Sc., in a book on milk, its nature and composition, says, as to means of preventing changes in milk:—

The great agent is heat. Cleanliness is not a less valuable instrument, cleanliness in every way, — on the hands of the milker, on the teats of the cow, in the milk pails and other receptacles used for holding the milk, in the byre, etc. Immediately after milking the milk should be cooled down; the lower the temperature, the better. On the other hand, it may be sterilized by heating. The addition of chemicals, so-called "preservatives," cannot be too strongly condemned. Even such comparatively harmless preservatives as bicarbonate of soda, boracic acid, salicylic acid and peroxide of hydrogen ought not to be used. Quite recently, also, formalin, viz., a 40 per cent solution of formaldehyde, has been used with great success as a preservative.

Dr. A. McGill, Bulletin 54, laboratory of the inland revenue department of Ottawa, says:—

It is true that we do not yet know enough of the physiological action of formalin, salicylic acid, borax, etc., to enable us to say just in what way and to what extent their presence in food is harmful or dangerous; but it is not unreasonable to suppose that substances so effective in preventing putrefactive change should interfere more or less with the functions of digestion, which are more or less analogous to such change. As the subject is a highly important one, I shall take the liberty of quoting a few opinions by leading English physicians, called out by a circular recently addressed to the profession by the editor of the London "Lancet" (see "Lancet," 1897, page 56):—

Sir Henry Thompson writes that he has long held the addition of antiseptics to food as undesirable, though he is unable to produce evidence that any one of them had given rise to deleterious action.

Dr. Pavy wrote that he did not consider our knowledge sufficiently extended to permit of it being taken for granted that no

injury is producible, although there is no evidence of injury to health. He points out that it is the vendor, and not the consumer, that is benefited.

Dr. F. J. Allen points out the possibility of daily accumulation of antiseptics quite sufficient to produce a gradual lowering of the standard of health.

Dr. Sims Woodhead draws attention to idiosyncrasy and cumulative effect, and dwells upon our ignorance of the action of certain drugs (*e.g.*, formalin) on food stuffs. He points out that, by the use of preservatives, foods of inferior quality may be doctored. He would make the use of antiseptics illegal, unless their nature and quantity be made known.

It is not to be forgotten that, while some disagreement as to the positively harmful effects of antiseptics when used by adults may be found among physicians, the presence of these powerful drugs in the food of infants admits of no justification.

RENOVATED BUTTER.

We have several times called attention to the increasing sale and use of butter which has been renovated by various processes and sold in a wholesale way as "process butter" or "sterilized butter." The managers of these renovating establishments buy up stale, rancid, unmerchantable and low-grade butters, of various degrees of badness. These are melted together and clarified. The oil is then chilled and the granules re churned with milk or cream. The resultant product has many of the physical characteristics of oleomargarine, and may be mistaken for it by some of the ordinary tests. Chemical analysis shows that the substance has an amount of volatile fatty acids below the ordinary average for butter, but much more than oleomargarine contains. We have taken several samples brought to us during the past year, and Dr. B. F. Davenport reported that the article could be properly called "an oleomargarine," and that "it is not the product ordinarily known as butter." This process butter is frequently sold dishonestly, and often the consumer is ignorant of its real character, and that raw material unfit for human food may have entered into its composition. Pennsylvania requires it to be branded and labelled as "renovated butter." This is an honest name, and we can see no objection to it. A New York butter

dealer says: “‘Renovated’ butter sounds hard, and it would have a killing effect on the trade in this State. But that is just what it is, and I see no reason why it should not be branded that way. It is a legitimate article, all the component parts except the salt and the coloring matter being the product of the dairy; but, in the interest of all concerned, the goods must be sold for what they are.”

It is this selling of them for what they are not that deceives, the consumer usually thinking that what he buys is fresh creamery butter. This deceptive business also injures the butter trade, for a dishonest dealer can undersell honest goods 2 or 3 cents per pound, and yet make more than the ordinary per cent of profit. These facts are causing an increasing agitation of the policy and principle involved in renovated butter, and a growing feeling in favor of the necessity of branding it.

BUTTER.

Massachusetts consumes much more butter than is manufactured in the State. The statistics of all the consumption cannot be readily secured, but the following table gives the Boston chamber of commerce figures for the receipts and sales in this one market: —

	1898. Pounds.	1897. Pounds.	1896. Pounds.
On hand January 1, . . .	2,473,600	2,898,000	1,659,434
Receipts for the year, . . .	50,609,552	51,107,033	50,972,255
Total supply, ...	53,083,152	54,005,033	52,631,689
Exports, deduct, ...	1,574,682	3,286,333	3,156,741
Net supply, ...	51,508,470	50,718,700	49,474,948
Stock on hand December 31, deduct, ...	2,829,160	2,620,680	2,898,080
Consumption, ...	48,679,310	48,098,020	46,576,868

This shows a reduction in receipts for 1898, occasioned by a great falling off in the export business. But the consumption is steadily increasing.

The amount which has been consumed is materially larger than it would have been had imitation butter been allowed full and free sale in a deceptive manner. On the very moderate estimate of curtailing dishonest sales to the amount of one-half of one per cent of the amount consumed, which no one will dispute, the law has prevented imposition and enhanced honest dealing to the extent of 243,400 pounds, which, at the average price of 20 cents per pound, amounts to \$46,680. This is based on the Boston market alone.

The following table shows the extreme quotation for the best fresh creamery butter in a strictly wholesale way in the Boston market for four years : —

	1898. Cents.	1897. Cents.	1896. Cents.	1895. Cents.
January, ...	22½	22	26	26
February, ...	21½	22	24	25
March, ...	22	23	24	23
April, ...	22½	22	22	21
May, ...	18	18	17	19
June, ...	17½	16	16½	20
July, ...	18½	16½	16½	19
August, ...	19½	19	17½	21
September, ...	21	22	17½	22
October, ...	21½	22½	20	23
November, ...	21	22	21	23
December, ...	21	23	23	28

The price for 1898 averaged about $\frac{1}{8}$ of a cent per pound less than for 1897 and $\frac{1}{10}$ of a cent per pound more than for 1896. But during the months of greatest depression — June and July — the price in 1898 did not drop so low by $1\frac{1}{2}$ and 2 cents per pound as in 1897. Prices in 1898 were better than in 1897 up to September; but for the last four months of 1898 there was a marked falling off, as compared

with 1897. The highest price quoted in four years is 28 cents, in December, 1895; the lowest is 16 cents, in June, 1897.

BOSTON MILK.

The following table gives the receipts, sales and surplus of railroad milk in $8\frac{1}{2}$ quart cans, brought into the greater Boston, as reported by the contractors' association : —

1898.	Received.	Sold.	Surplus.
January, ...	947,935	708,677	239,258
February, ...	835,916	635,892	200,024
March, ...	960,443	728,188	232,255
April, ...	965,260	690,042	275,218
May, ...	1,083,969	725,507	358,462
June, ...	1,142,161	711,104	431,057
July, ...	995,552	748,414	247,138
August, ...	893,927	736,426	157,501
September, ...	895,794	729,885	165,909
October, ...	928,309	737,652	190,657
November, ...	818,027	704,130	113,897
December, ...	850,468	708,765	141,703
	11,317,761	8,564,682	2,753,079

	Receipts.	Sales.	Surplus.
1897, ...	11,798,191	8,738,572	3,059,619
1896, ...	10,772,108	8,087,378	2,684,730
1895, ...	9,856,500	8,040,732	1,815,768
1894, ...	9,705,447	7,657,421	2,048,026
1893, ...	9,263,487	7,619,722	1,643,765
1892, ...	9,212,667	7,315,135	—

The noticeable feature of the business the past year was the immense surplus in June, followed by a marked falling off in receipts during the last half of the year. In round figures this decrease from receipts during the corresponding months of 1897 was as follows : —

July,	.	.	.	.	.	.	.	.	18,000
August,	.	.	.	.	.	.	.	.	73,000
September,	.	.	.	.	.	.	.	.	61,000
October,	.	.	.	.	.	.	.	.	109,000
November,	.	.	.	.	.	.	.	.	144,000
December,	.	.	.	.	.	.	.	.	95,000
									500,000

This falling off is probably due to several causes. The increased surplus in April, May and June reduced the average income per can to producers ; this, coupled with higher prices of cows, has undoubtedly been largely instrumental in leading to reduced production. Sales in 1898 have fluctuated more than the sales in 1897. In August there was an increase of 16,000 cans, and in April a decrease of 43,000. Every month has shown a decrease except January, March and August. It is hardly supposable that the consumption of milk in a growing municipality has fallen off. The presumption is that this falling off of the contractors' sales has been partly made up by the increased use of cream and partly by an increase of milk from near-by sources. This milk has for several years been a cause of some anxiety, as well as demoralization, though no more so this year than usual. Reduced supplies have offset this and steadied the market, so that the close of the year finds it in better condition than for some time. The extreme retail price of milk has continued, as heretofore, at 7 cents per quart where milk is delivered to customers in quart or pint cans. Much is sold from grocery stores at 4 and 6 cents. In sales in a jobbing way by the can to hotels, restaurants, public institutions, etc., the competition has been sharp, and many stories have been told of extremely low prices. The nominal price to peddlers has been 30 cents in summer and 33 cents in winter. The movement to supply a higher grade of milk at a higher price makes headway slowly, though each year

notices a little gain in that respect. Much of the near-by milk should be held at the full price or a little more, on account of its greater freshness, instead of being offered in competition with railroad milk at a lower price.

The price of milk to the producers has been the same as for previous years. As has been explained in previous reports, the price of milk is based upon a theoretical Boston price, subject to a scale of discount depending upon the distance from Boston as follows:—

	Cents.
For stations between 17 and 23 miles from Boston, ...	8
For stations between 23 and 36 miles from Boston, ...	9
For stations between 36 and 56 miles from Boston, ...	10
For stations between 56 and 76 miles from Boston, ...	11
And 1 cent more for each additional 20 miles.	

When this plan was first established, the theoretical Boston price was expected to be the selling price of wholesalers to peddlers, and the discount was supposed to represent the expenses of doing business and the profit of the wholesalers. During the past few years of smaller margins milk has not been sold at the theoretical Boston price into 2 or 3 cents per can, consequently this figure has been to an extent misleading. During the past year the discount scale has been reduced 2 cents.

The theoretical Boston price per can of $8\frac{1}{2}$ quarts for a number of years has been as follows:—

YEAR.	Summer.	Winter.	YEAR.	Summer.	Winter.
	Cents.	Cents.		Cents.	Cents.
1886, ...	30	36	1893, ...	33	37
1887, ...	30	36	1894, ...	33	37
1888, ...	32	38	1895, ...	33	37
1889, ...	32	38	1896, ...	33	35
1890, ...	32	36	1897, ...	33	35
1891, ...	33	37	Average (12 yrs.),	$32\frac{1}{4}$	$36\frac{3}{8}$
1892, ...	33	37			

During the year 1898 the price has been 31 and 33 cents, — 2 cents reduction from the figures of the previous two years, but netting the farmers the same on account of the reduced discount.

Early in the year there was a contest between contractors and producers as to the amount of surplus for which the contractors should pay full price. The producers asked the full price on an amount of the surplus equal to 5 per cent of the sales; the offer was on an amount equal to $2\frac{1}{2}$ per cent of the sales. A proposition to refer the difference to the board of arbitration fell through, owing to a misunderstanding.

There has been undertaken during the past season what may prove an entering wedge to a material improvement of the city milk supply. One large firm of milk wholesalers, compelled to move its business by changes in railroad tracks incidental to the new union station, has built a new milk depot. It is constructed of brick, iron, cement and artificial stone, so that it can be kept scrupulously clean. The milk will be cooled by artificial refrigeration, instead of ice, which is more cleanly. But the distinctive feature of the building is the possibility of a radical change for the better in the method of distributing milk. Now the peddlers take the $8\frac{1}{2}$ quart cans from the cars to their individual milk headquarters, which are not always over clean, and which sometimes are in unpleasant proximity to stables, sewers, etc. Here the milk is mixed, put in small retail cans, kept in refrigerators over night, and delivered the next morning.

This new wholesale milk house is to be fitted with porcelain-lined vats, where the milk will be mixed and cooled. It can then be drawn into cans or bottles for consumers, kept in cold storage at known and uniform temperature till needed, and sold to peddlers under a guarantee of quality, for immediate distribution. This plan also has the possibility of keeping away from the city trade all cans used in the transportation of milk, making possible the return of clean cans to the farmers.

A scrap going the rounds of the dairy papers draws a somewhat fanciful view of the future condition of the city milk trade. It says: —

The creameries, milk rooms, vats, etc., will be either of tile or porcelain lining; apparatus for sterilizing and pasteurizing milk will have to be purchased; all milk will be certified, and nothing sold except in glass jars; every concern will employ a graduated chemist and a veterinary surgeon. Milk stores will be veritable crystal palaces, compared with the ones in use to-day, and all the employees will be uniformed, and compelled to undergo a civil service examination once a year. More advance will be made on this line in the next ten years than has been made in the past fifty years. A complete revolution is coming. Almost the same progress will be made on the dairy farms among the men who produce the milk. The production, care and handling of milk is receiving more attention to-day from all classes than ever before in our history.

The above paragraph was written and published without any knowledge of the new building in this city; but it may be that Boston will be able to show the world substantial progress along the lines indicated in the above paragraph much sooner than the writer of it anticipated.

Early in the year a study of the condition of cans returned to the farmers was undertaken, in connection with the Milk Producers' Union. Shipping tags were provided for the members of the union, and a circular sent them, announcing that all cans received by them in an unduly filthy condition could be sent by express to the executive officer of the Dairy Bureau for inspection and report. This brought out only 20 cans in three months. The number was much less than we had supposed would be sent, but the nauseating filthiness of those which were returned made up for lack of number, — rotten curd, putrefying slime, rotten eggs, kerosene oil and human excrement were among the ingredients, while the odors beggared description.

OUTSIDE OF BOSTON.

In the other cities and in the larger towns the milk supply has in the main been large, and prices weak during the year. In Boston the peculiarity of the wholesale system is such that the wholesalers keep the surplus milk off the market, manufacturing it into butter. This has a great influence in steadying the retail market, and in reducing to the lowest

terms the temptation to make concessions in prices. Such conditions do not exist outside of Boston, and from nearly every considerable town or city have come complaints of much cutting of prices, though nominally the prevailing price throughout the Commonwealth seems to be 5 and 6 cents. Lynn, Newton and one or two other places report 7 cents as an extreme for ordinary milk. In some places the under-bidding is done by means of a ticket system, tickets good for 22 or 24 quarts being sold for \$1.

Though the supply has been full, all reports received indicate a fair demand. There is no great movement in the State towards selling a superior article at a better price than the average, or in selling certified or guaranteed milk, but reports from a number of places show a tendency in that way. The use of glass bottles is increasing, and this has an indirect tendency to improve the supply. A correspondent from Worcester says there is a growing tendency to improve the quality of milk by the introduction of Jersey cows. In Newton and Brookline there is a growing trade in milk produced from well-known herds of better than the average quality, at 8 and in some cases 10 cents per quart. The milk inspector in Holyoke says there has been a marked improvement in the quality of milk sold in that place. From Lowell, Framingham and one or two other places come reports of the introduction of pasteurized milk, but that is not as yet in general use. The Newton milk inspector reports that, of nearly 2,000 samples examined by him, the greater number were of higher standard than required by law.

INSPECTION.

We have previously recommended a system of inspection of dairy herds and surroundings, based on the Michigan law. This furnishes an educational system which can be of great service, with a minimum of objectionable features. The plan calls for only an inspection of herds and stables, and a report. A good report is a good advertisement to a thrifty, intelligent dairyman; a poor report is a stimulus to better conditions. We are informed by the Michigan dairy commissioner that the plan works admirably there. Its general

features have been endorsed and recommended by the Massachusetts State Grange. We append two sample reports from a Michigan report :—

At Ionia.

A. M. Welch.—Cows in very good condition; stables exceptionally clean; ventilation good; sanitary conditions excellent; uses spring water; drainage good. Cows are cleaned twice a day; wells and ceilings of stables whitewashed twice each year; has clean, well-ventilated cooling room, and all modern appliances for handling milk in a neat and systematic way.

At Cadillac..

C. J. Holman.—Stables unclean; drainage imperfect and manure allowed to accumulate near stables; ventilation fair; sanitary conditions poor.

CREAM. — CONDENSED MILK.

Sales of cream continue to increase, and, as much of the market cream is manufactured on the factory plan in large creameries of good standing, the quality is to a great degree uniform and satisfactory. As the cream is sold to the trade in small cans, the opportunity to tamper with it is largely removed. It would be an advance step for the cans to have a label containing a guarantee of quality. This would be no hardship to these creameries or other leading producers, for the cream is now of good quality, but it would educate consumers to differences in the quality of cream and to the relation between varying qualities and price; it would also reduce any tendency for less scrupulous dealers to sell a lower grade at the regular price.

A Philadelphia newspaper says :—

Probably no recent development of the retail grocery business has been more noticeable of late years, especially in the mill and labor districts, than the increase in the sale of condensed milk. Grocers who formerly sold none of this now sell stacks of it, and grocers who used to sell a few cans a month now sell several cases. Every condensed milk manufactory in the country has increased its output 25 per cent this year, and it is sold up to the handle.

Condensed milk is of more varying composition than market cream, and in many cases the percentage of fat is not increased by the condensation process in the same ratio as the solids not fat are increased. Condensed milk should mean milk which has been thickened by driving off the water. If any of the fat has been removed, that should be stated. When condensed milk is artificially sweetened, that fact should also be stated on the label. Usage has led the consumer to expect condensed milk to be sweetened. There is no need to add sugar to preserve condensed milk. Some good brands contain no sugar. When condensed milk is sugared, the consumer can add five to eight volumes of water, and still have a product which does not appear over thin.

EDUCATIONAL.

The educational part of our work has not been neglected. The acting executive officer has answered twenty-five calls to address various gatherings. He has also been called upon several times to test milk at dairies with the Babcock tester. He has also made tests of milk and cream brought to him. During the summer offers were made to the New England Milk Producers' Union and to the Massachusetts Creameries Association to hold a series of combination dairy institutes with each organization. The offers were gratefully received. As a result, four profitable, well-attended creamery institutes were held at Granby, Enfield, Cummington and Easthampton, in co-operation with the creameries' association. The institutes afforded an opportunity to the farmers who produce cream to meet practical buttermakers and Dr. J. B. Lindsey. Here the actual problems which perplex them were talked over, much interest aroused, and we believe considerable good done.

The representative of the Bureau has acted as expert judge at the exhibition of the Worcester South Agricultural Society, to award prizes for the cow producing the greatest amount of butter fat in twenty-four hours on the society's grounds. The testing was done with the Babcock tester in the exhibition hall, before all who wished to witness it, with the following result:—

High-grade Guernsey (C. L. UNDERWOOD, East Brookfield, Mass.).

	Weight of Milk.		Per Cent of Fat.	Weight of Fat.
	lbs.	oz.		lbs.
Night, ...	17	14	4.00	.715
Morning, ...	17	9	3.80	.667
Total, ...	35	7	—	1.382

High-grade Ayrshire, Nine Years Old, Two Months in Milk (L. WOODIS, North Brookfield, Mass.).

	lbs.	oz.		lbs.
Night, ...	15	10	3.60	.562
Morning, ...	15	8	4.20	.651
Total, ...	31	2	—	1.213

Grade Jersey, Ten Years Old (MELVIN SHEPARD, Sturbridge, Mass.).

	lbs.	oz.		lbs.
Night, ...	10	0	5.40	.540
Morning, ...	9	8	5.80	.551
Total, ...	19	8	—	1.091

Jersey (BOND & SONS, Charlton, Mass.).

	lbs.	oz.		lbs.
Night, ...	9	8	6.40	.608
Morning, ...	8	11	4.00	.347
Total, ...	18	3	—	.955

Jersey, Four Years Old, Ten Days in Milk (C. D. RICHARDSON, West Brookfield, Mass.).

	lbs.	oz.		lbs.
Night, ...	8	3	5.80	.475
Morning, ...	8	2	5.80	.471
Total, ...	16	5	—	.946

Thoroughbred Jersey, Ten Years Old, Four Months in Milk (JAMES FREELAND, Sutton, Mass.).

	Weight of Milk.		Per Cent of Fat.	Weight of Fat.
	lbs.	oz.		lbs.
Night, ...	9	6	4.80	.450
Morning, ...	9	2	5.00	.456
Total, ...	18	8	—	.906

This educational work is sometimes discouraging, on account of the failure to see immediate results. It is often like the seed put away out of sight. But we believe that a harvest of increased intelligence and profit is inevitable, though in the future.

The duty of representing the State at the National Convention of Dairy and Food Commissioners has also fallen upon me. These conferences of persons engaged in similar work are very valuable, tending to promote efficiency of action.

The following is the manner in which the appropriation of \$7,000 has been expended:—

Members of the Bureau, travelling expenses and attending meetings, ...	\$382 47
Agents' salaries, ...	2,112 00
Agents' expenses, ...	2,063 99
Chemist, ...	810 00
George M. Whitaker, travelling and office expenses, supplies, mileage tickets, etc., ...	827 93
Educational work, ...	106 50
Printing, ...	45 16
Supplies, ...	41 30
Total, ...	\$6,389 35
Unexpended, ...	610 65
	\$7,000 00

GEORGE M. WHITAKER.

Accepted and adopted as the report of the Dairy Bureau.

D. A. HORTON.
J. L. ELLSWORTH.
C. D. RICHARDSON.

REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATING THE GYPSY MOTH.

Commonwealth of Massachusetts.

To the Massachusetts State Board of Agriculture.

Your committee, in charge of the work to prevent the spreading and secure the extermination of the gypsy moth in this Commonwealth, herewith presents the report of expenditures and of the work as carried on during the year 1898.

As the appropriation for 1897 had been insufficient for the year's work, the force of men had to be greatly reduced during the latter part of December, 1897, and on Jan. 1, 1898, only 159 experienced men were at work. The balance of the appropriation of 1897 on hand Jan. 1, 1898, was \$2,298.94. The indebtedness incurred for labor in December, together with other unpaid bills, was nearly sufficient to use up this balance; so that, notwithstanding the reduction of the force, the appropriation for 1897 was practically exhausted by that year's work.

During the month of January, until the pleasure of the General Court can be made known, the law empowers the committee to continue expenditures at the average monthly rate of the preceding year. The force was increased accordingly to 200 men, but on February 1, the Legislature having made no provision for carrying on the work, the committee was forced to discontinue it.

An emergency appropriation of \$20,000 was made in February, and the men were again put at work; but, the expenditures which the law had empowered the committee to make during the month of January having to be deducted from this sum, there was left only \$11,087.09 of the emergency appropriation. This was soon exhausted, and, as the Legislature had not yet decided upon the amount of the annual appropriation, the force was again necessarily laid off.

During those portions of the winter and early spring, when means were provided to keep the men at work, they were employed mainly in cutting and burning underbrush and dead and decaying trees in the infested woodlands, and in destroying the eggs of the gypsy moth on the trees on these lands. This work is extremely effective. It contributes indirectly to the destruction of the moth by destroying its hiding-places and directly through egg-destruction by preventing the hatching and spreading of the caterpillars. It also greatly facilitates the work of the summer, by reducing the number of worthless trees on which the moth feeds, and which otherwise would have to be burlapped, inspected, and perhaps climbed during the summer work. The removal of the undergrowth drives the caterpillars to the trees, where they are readily taken under the burlap bands. Again, the destruction of the moth in the egg manifestly greatly lessens the work of caterpillar-killing in the summer, and so makes a material saving in labor, time and money.

The appropriation of \$180,000, in addition to the emergency appropriation, was not available until well into April. It will be seen, therefore, that more than one-fourth of the year had passed before the full appropriation for the season's work became available. The plans and purchases for the season had then to be decided upon, and the necessary number of men engaged, examined and set at work.

The various interruptions in the work, which, through lack of sufficient means, began in December, 1897, and occurred again and again in the early part of 1898, had been most detrimental in their effect upon the force. Many experienced men had removed to considerable distances; some had found better jobs; and it was difficult, in fact, impossible, to get them all together again. The force was increased as rapidly as it could be under these circumstances, and on April 23, 322 men were at work. It was too late then to do much of the important spring work of burning over the ground with oil in the badly infested central colonies, and this work had to be abandoned for that of putting burlaps on the trees, for the caterpillars had appeared and were likely to spread.

A considerable tract of infested land in Malden and a smaller tract in Medford had been burned over, but there were still greater tracts in both cities which were necessarily left unburned, partly because of the wet weather, but mainly because the work of the caterpillar season was upon us, and it was absolutely necessary that this work should be done in time. It was stated in the committee's report of 1897 that the moths were spreading in the woodlands in the central part of the infested region, and that the caterpillars were being carried out therefrom on vehicles, persons and horses into territory in the outer towns that had been previously cleared of the moth. The increased danger of such distribution of the caterpillars, resulting from summer travel on the new roads, boulevards and trolley-car lines extending into or through these central infested woodlands, has been pointed out in previous reports. To check this spread, now that the eggs were hatching, it was necessary to destroy the caterpillars.

The evil results, due to the lapse of the spring burning, were soon seen in the vast number of caterpillars which appeared in the badly infested central woodlands, where the work of burning and spraying with oil had not been finished. Could this burning have been done, millions of caterpillars would have been destroyed in embryo which later hatched from the eggs deposited among the dead leaves on the ground and swarmed up the trees. A large part of the work which afterwards became necessary would have been avoided, and the spread of the caterpillars from these central localities to outer regions already cleared, which occurred during the summer, would have been sooner stopped. The eggs on the trees in these regions had been destroyed during the fall and winter work; and, had it been possible to supplement this with the burning, thus destroying also the eggs on the ground, extermination in these central tracts would have been advanced a year over what we were able to do under actual conditions. Fifty men, who otherwise might have been used in exterminating the moth from other towns, were necessarily kept in Medford all summer employed in killing hosts of caterpillars which would never have existed had the appropriation been made

in time to enable this burning to be done. Had the money been available earlier, so that more thinning out of undergrowth could have been done in the badly infested woodland centres, the work of the burlap season would have been much more effective; and a vast amount of burlapping work could have been saved had it been possible to do thoroughly the spring cutting. As it was, burlap bands being now the principal means to be relied upon to exterminate the moth, nearly two million trees had to be burlapped.

Arsenate of lead was also used, as in 1897, as an insecticide to check the caterpillars which by lack of prompt appropriation were allowed perforce to hatch from the eggs. Only a small amount of effective spraying could be done, because of the almost constant rainy weather which continued during the month when spraying would otherwise have been effective. Where arsenate of lead could be used in suitable weather, its effect on the gypsy moth caterpillars was satisfactory and more fatal than any insecticide heretofore used for the gypsy moth work.

Owing to the aforesaid disadvantages under which the work of the season was conducted, it was found necessary to rely almost entirely on burlapping for the destruction of caterpillars, and the numerous burlaps put on, together with the care used in attending them, are largely responsible for the great improvement in the condition of the infested region which can now be reported.

The size of the appropriation made it possible for the committee to retain the entire force for the fall work, instead of discharging a large part of the men as soon as the burlap season was over, as had been the case in years past, and to begin immediately the work of burning over the ground. About two hundred acres of the worst-infested territory, mostly woodland, a part of it being in the Middlesex Fells reservation, were burned over with fuel-oil in August and September. The dead leaves, dead wood and other *débris* were thus destroyed, together with the eggs which were deposited upon or among these materials. At the same time expert men were employed in killing the comparatively few eggs of the moth which still remained

upon the trees. The improvement over the condition of last year is very marked. In some of the worst-infested localities hardly one egg-cluster can be found, where hundreds were destroyed in 1897. Many miles of stone walls were treated by spraying with crude petroleum to destroy the moth eggs deposited beneath the stones. It was ascertained by experiment that the application of this crude oil in the form of a spray will destroy the eggs as effectually as can be done by fire or the application of creosote. Experiment has proved that spraying with oil in this manner is as effectual as tearing down the walls and then killing the eggs by hand. It is also much less expensive.

While the work of egg-killing was still going on, gangs of wood cutters were organized, and the work of clearing up underbrush and cutting decaying trees, which had not been finished in the spring, was continued through the fall. About two thousand acres were thus treated, and it is hoped that in 1899 all the necessary work of this sort remaining can be done before the eggs hatch in the spring. An inspection is also going on of those towns which, on account of inadequate appropriations, have not been thoroughly examined for three or more years. As was to be expected, a few new infested spots have been found in these towns, but they have been discovered in most cases in time to prevent any great increase or spread.

From the first it has been the plan of the committee to begin the work of extermination in the outer towns, forcing the moth towards the centre, and then, by concentrating all forces available, to crush out the large colonies in the central towns. Unfortunately, the policy of past Legislatures in scaling down appropriations has prevented the carrying out of this plan, and has permitted the increase and consequent spread of the moth in the central towns. As has been stated in a former report, the increasing danger of a spread of the moth in towns already cleared, by reason of the increased facilities for distribution from badly infested woodlands in the central towns, led to a change in the original plan; and the greatest effort of the season has been put forth to stamp out the moth in these badly infested central woodlands, and thus prevent reinfestation of the

outer towns already cleared. It is therefore here in the central towns that the work of the season shows to the best advantage. In spite of the hindrances caused by the delay of the appropriation, the moth has been so reduced in these central woodlands that egg-clusters are now in most cases rare and hard to find, even in localities where the caterpillars were killed by millions only so recently as the past summer. In the Saugus woods, where the caterpillars taken in past seasons have been estimated at thousands of bushels, it is difficult to find egg-clusters to-day. In the woodlands of the Mystic valley, outside of Medford, the same condition prevails, and egg-clusters can now be found there only by long and tedious search. In Malden, Medford, Everett and Melrose egg-clusters in small quantities are still to be found; but, if the work now being done can be continued without interruption until the time for the hatching of the eggs in the spring, the egg-clusters will be very rare in all these places. In seven towns within the infested territory no moths have been found this year, and in half the others embraced in this territory very few were found in the fall inspection. If the work now being done can be carried on without interruption until spring, it is believed that very few if any caterpillars will be distributed next summer from the woodland centres to the outer towns.

In view of the encouraging progress made in 1898, in spite of the delay in making the appropriation, your committee believe that the attempt to exterminate the gypsy moth in eastern Massachusetts has been justified by the results already attained, and its practicability demonstrated. They therefore plan to continue the work in 1899 on the same lines as in 1898. An appropriation of \$200,000 is therefore recommended for the work of the ensuing year, this sum to be expended in no half-way measures of suppression, with the result of continuing the work indefinitely, but with the sole view to the extirpation of the gypsy moth from this Commonwealth.

So much progress having been reported, the question will naturally arise, Why, then, is so large an appropriation now needed? In answer to this, it must be stated that there are

large areas of infested woodland which are either included in metropolitan or municipal parks, or which, from their location, are of high value, the trees on which cannot be cut, but must be burlapped, carefully inspected and the underbrush and sprouts kept down. Unless this can be thoroughly attended to each year for three or four years, until the moth is exterminated in them, the creature will certainly increase and spread, thereby infesting more woodland and increasing the cost of inspection and treatment.

To make sure that no infestation has been overlooked, and to watch for indications of reinfestation, it will also be necessary for a term of years to examine periodically all the territory of all the towns in which the gypsy moth has at any time effected a lodgement.

The increased appropriation of 1898 has enabled the committee effectually to check the spread of the moth from the central woodlands. In future, therefore, the work of the committee can be more directly and effectively applied to extermination than heretofore. Although a vast improvement has been made this year, — an improvement far greater in the central towns than ever before, — yet, as has been said, a careful examination of these towns, necessitating much time and large cost, must be continued for several years before the moth can surely be declared exterminated from them.

The completion of a thorough examination of the outer towns is also a prime necessity. Dr. L. O. Howard, entomologist to the United States Department of Agriculture, in his report on the gypsy moth exterminative work, made to the United States government since the completion of the committee's last report, pointed out the advisability of carefully inspecting a belt of towns beyond the limits of the known infested territory, for the purpose of discovering gypsy moth infestation should it by any chance exist there. The committee fully recognize the wisdom of the measure thus suggested, and would have undertaken it earlier, had means permitted. Should an adequate appropriation be granted by the Legislature, all that can consistently be done in this direction during the coming year will be done.

In accordance with another recommendation of Dr. Howard, the committee plan also to make a special appeal to citizens, resident in or near this extralimital belt, to aid so far as may be in this search work. In his general review of the warfare against the gypsy moth Dr. Howard speaks in the highest terms of the faithfulness and efficiency of those in charge of the work. The following extracts from his report bear directly on the work of the present year, and hence may fittingly be appended : —

At the present time there can be little doubt that the extermination of the insect is possible, and that it will be only a question of a few years, if adequate State appropriations are continued. The simple fact that it has unquestionably been exterminated over considerable stretches of territory, and that extensive colonies existing in the most disadvantageous territory for the prosecution of remedial work have been so thoroughly destroyed that not an individual has been found for three years with the most rigid annual inspection, is sufficient proof of this possibility ; for what can be done for one section like this can be done for all, if the means be sufficient.

After a review of the entire work . . . it cannot but be admitted that the effort of the State to exterminate the moth has been wise. It is true that a large amount of money has been expended, and it is also true that much more money must be expended before extermination can be accomplished ; but it is undoubtedly safe to say that the money which has been and will be spent by the State in this work is but a drop in the bucket to the loss which would have been occasioned by the insect had it been allowed to spread unchecked. . . . The question as to whether the State has done the right thing in appropriating for the extermination of the insect instead of holding it in subjection, and as to whether the money has been used in the best possible way to forward this end, may both be answered emphatically in the affirmative. . . . The writer believes that the condition of the entire infested territory at the present day is such that, with the prompt appropriation asked for by the committee at the beginning of the coming session of the Legislature, the work that will be carried on during 1898 will be of so effective a character that even those who most gravely doubt the policy of the State's efforts will be convinced of the efficacy of the work. A continuation of the appropriations for a few more years is unquestionably a necessity. Were the appropriation to lapse a single year, the work which has been done during the past six years would largely be lost.

In accordance with an act of Congress, Dr. Howard again in the fall of 1898 made an investigation, to determine the progress of the work since 1897. That what was seen during his last visit has confirmed his conclusions drawn from the extended inspection of 1897, may be judged by reference to the report of Prof. C. H. Fernald, the entomologist, which follows this report.

In order that the Legislature may fully comprehend the difficulties under which your committee has labored, it becomes necessary here briefly to refer to the unsatisfactory conditions under which the work has been conducted for the last five years.

In the report on the work for the year 1892, published in January, 1893, your committee estimated that there were then about four hundred acres of woodland infested, and suggested that, at a cost of \$50,000, it might be cut down and burned, thus eliminating this factor from the problem. Although in the same report the committee stated that it was believed that with sufficient means and in several years' time these forest lands could be cleared of the moth without destroying the timber, the mere suggestion of its destruction caused much opposition on the part of the public, which apparently helped to reduce that year the size of the appropriation. The appropriation asked for (\$165,000) was cut down to \$100,000, consequently very little could be done in protecting these woodlands, and the moths therein continued to spread. Had the sum then estimated by the committee been granted, the spread which has since occurred would have been prevented.

A year later (1894) the committee reported that there were twelve thousand acres of woodland, containing five million trees, in the infested region which were in immediate danger of becoming infested, and again recommend an appropriation of \$165,000. The committee also called attention to the fact that small areas here and there in this woodland were known to be infested, and emphasized the necessity of appropriating sufficient money to attend to the woodland problem at once. But the appropriation was again cut down to \$100,000, and, in spite of all that could be done with this limited amount, the moths continued to spread in these woodlands.

In January, 1895, the committee again called the Legislature's attention to the dangerous condition of the forested land, and pointed out that this condition was due to the fact that not enough money had been provided to make a thorough search of the whole tract, or even to destroy the initial colonies found. In view of the fact, as stated in this report, that the moth had now become scattered through the woodlands from Lexington to the sea, the committee recommended that \$200,000 be appropriated, at the same time protesting against being required to exterminate the moth with an insufficient grant; and stated its belief that, if the Legislature was unwilling to provide sufficient means for restricting the spread of the gypsy moth and holding it in check, the work should be discontinued entirely. The Legislature, however, appropriated only \$150,000.

In January, 1896, the committee reported that its predictions as to what would happen in such a case had been verified, and that the condition of the forested land was now worse than ever before. Many places, some of them of considerable area, had been found infested. The caterpillars were found during the feeding season in enormous numbers, destroying the foliage, and in some cases the trees were stripped. The committee was obliged that year to cut down and burn considerable areas of forest, and reported that, while lands other than woodland were in an encouraging condition, more new places had been found in the woods than had been stamped out in such lands. In addition to the drawback of smaller appropriations than were recommended, the work had suffered severely during all these years from delay of action by the Legislature. The committee declined to be held responsible for failure if its plans and recommendations were to be ignored; and, furthermore, reiterated what was said the previous year, to the effect that either sufficient means should be provided, or the work discontinued entirely, and again recommended an appropriation of \$200,000. Only \$100,000 was granted.

In January, 1897, the committee once more reported to the Legislature that the condition of the central woodlands was growing worse; that in places in the woodland where trees had been stripped two years in succession, many of

them were dying. The committee also called attention to the fact that in no year since 1892 had there been an opportunity of carrying out the plans made for the following season, and reiterated a former statement, that the only way to prevent the spread of the gypsy moth was to do everything possible to completely eradicate it from the land. The committee recommended \$200,000 as absolutely necessary for the work of 1897. Only \$150,000 was appropriated.

In January, 1898, the committee called attention to the fact that the moths from the central woodlands were spreading into the outer towns, thus reinfesting towns already cleared, as in former reports had been predicted would be the case if the reduction of the appropriations continued. In this report it was urged that to continue the partial policy of the last few years would be unwise. The belief was again expressed that the only way to prevent the spread of the gypsy moth was to exterminate it; and it was urged that it would be wiser not to appropriate another dollar of the State's money than to again reduce the appropriation, for the result in either case would eventually be the same, *i. e.*, the final escape of the moth from its present limited territory. The Legislature was requested and urged to appropriate \$200,000.

It was shown before committees of the House and Senate that during all these years the plans of the work, the methods used and the feasibility of the moths' extermination by these methods had all been endorsed by all of the most eminent economic entomologists of the country who had visited the work and personally examined all phases of the problem. The great injury which the moth is capable of doing had been fully set forth before the committees of the different Legislatures, both by those who had suffered from its ravages and by extracts from European authorities. It was shown that the Legislature had not for five years appropriated for the work the amount estimated by the committee as absolutely necessary to do the work for any one year. The Legislature of 1898 finally appropriated the full amount asked, \$200,000, although too late in the season to be used to the best advantage. Later on a sum not ex-

ceeding \$10,000 of this sum was set aside to be used for preventing the spread of the brown-tail moth.

The members of this committee desire to register here their solemn protest against being obliged by law to undertake further the extermination of the gypsy moth unless the means estimated by them as absolutely necessary for this extermination be furnished.

Your committee's work, like that of other committees of this Board, is done without compensation, for the public good. The members have given much time and their best efforts each year for the success of this work, and believe that their careful estimates in regard to carrying it on with economy should be accepted by the Legislature, or that they should be relieved from the duty of further conducting it.

The committee desires again to place on record the belief that extermination is certain if sufficient means can be promptly provided, and also the belief that, unless the appropriation of \$200,000 can be made, it will be better to give up the work.

The conduct of this work has been repeatedly indorsed by leading agricultural organizations. The State Grange, Patrons of Husbandry, adopted at its annual meeting in Worcester in December a resolve urging the Legislature to appropriate sufficient money to carry on the gypsy moth work vigorously, and to ask the national government to assist.

The scientific and experimental work has been continued in charge of Mr. A. H. Kirkland, assistant entomologist to the committee, under the direction of Prof. C. H. Fernald. The study of the various insect enemies of the gypsy moth has been continued; there has also been further investigation in regard to insecticides. Arsenate of lead, which was first brought out as an insecticide by Mr. F. C. Moulton, a chemist in the employ of the Board, has been brought to perfection by the studies of Mr. F. J. Smith, a chemist still in our employ. As this was the first poison found which could be used effectively in spraying for the gypsy moth, very little attention was given by your committee to the improvement of spraying machinery until arsenate of lead was proved to be a success as an insecticide. Since then

the field director's assistant, Mr. E. C. Ware, has made a special study of insecticide machinery, and as a result has perfected spraying machinery, especially adapted for use on the gypsy moth and other insects.

THE BROWN-TAIL MOTH.

When, early in May, 1897, the brown-tail moth was first discovered in Somerville, your committee, believing it to be one of the worst pests of Europe, proposed to allow it no time to spread, but to stop it immediately where it then was. In pursuance of this plan, men were put at work to spray and otherwise destroy caterpillars in the worst-infested territory, so as to prevent the spread of the moth. It was hoped that the Legislature would promptly make an appropriation of \$10,000 to stamp out at once the brown-tail moth, and thereby prevent its spreading into other towns. It was too late to put in a petition to the Legislature, the time for entering new business having passed. The conditions were explained to the Governor, who sent to the Legislature a message on the subject. The matter was referred to the ways and means committee, who reported an appropriation of \$10,000, to be taken from the amount already appropriated for the gypsy moth. This bill failed in the House of Representatives. A bill drawn by a member of the House was then substituted, making it mandatory for citizens to destroy the nests of the moths upon their premises. In the mean time, the committee, the Legislature not having endorsed its action, was obliged to call off its workmen; and the caterpillars, having undergone their transformations, emerged as moths and spread over the country. A strong southerly gale ensuing in July, the moths were undoubtedly blown into the towns to the north of Somerville. As both sexes fly, they are scattered about much more readily by the wind than is the gypsy moth, the female of which does not fly.

By the new law the Board of Agriculture was required to make inspection, to notify the town authorities wherever the brown-tail moth was found in their municipalities, and to notify citizens whose premises were found infested; but

no money was provided to carry out this section of the law. The secretary of this Board, however, took the responsibility of performing the various duties by this law imposed upon him as executive officer of the Board, and the expenses were paid from the incidental fund ordinarily used for other purposes. It was hoped that, even though the spread of the moth had not been stopped as it might have been, had an appropriation been provided and put at once in charge of the Board of Agriculture, individual effort might serve to hold the increase of the moth in check. The efforts of the Board aroused the authorities of Somerville and Cambridge to action, and, as these were the cities most infested, it was hoped that their energetic action might not only check the increase of the moth within their limits, but also prevent its spreading widely. The authorities of Somerville and Cambridge placed the enforcement of the law in the hands of the local police; and, as the appropriation for the gypsy moth work became exhausted about the time the brown-tail moth law was being enforced in these cities, many of the gypsy moth employees secured employment in destroying the webs on the trees, either for private owners or for the municipalities. Thus a force of expert men was placed at the disposal of all those inclined to comply with the law. The conditions, therefore, for a thorough test of the result of the workings of such a law were ideal. That the result was very unsatisfactory is now shown by the refusal of many property owners to comply with the requirements of the law; by the failure of the city authorities to prosecute such people for their negligence; by the consequent spread of the moth from place to place, because no work was done in places adjoining those which had been carefully cleared, so that the infested area in these cities is now fully as large as in 1897; by the spread of the moth into many other towns outside the region infested in 1897; by the repeal of the law of 1897, and the final turning over of the whole matter to the Board of Agriculture.

The gypsy moth committee had examined considerable territory, to determine the spread of the brown-tail moth; and, believing that it had spread since the spring of 1897 over an area nearly as large as that infested by the gypsy moth, was not inclined to go before the Legislature of 1898

and favor a small appropriation for its extermination. No appropriation was made therefore for the purpose of destroying the brown-tail moth; but a sum not to exceed \$10,000 was finally set aside by the Legislature from the appropriation already made for the extermination of the gypsy moth, to be used as required to "prevent the spread of the brown-tail moth" in the Commonwealth. This bill did not pass the Legislature until nearly the end of the session, and so late that it was impossible for the Board then to take any means whatever to check the spread of the brown-tail moths, which were then in the chrysalis, from which they emerged in a few days to fly about the country. Investigation was soon begun, however, with a view to learning the experience with the species in Europe. Considerable spraying was done when the August brood of caterpillars appeared, and an examination of the region surrounding the towns known to be infested was made as soon as the leaves fell.

Later a rapid inspection was made, to determine the extent of the region infested by the brown-tail moth. This inspection had not been finished Jan 1, 1899, when the money appropriated for the brown-tail moth work was exhausted. At that time this moth had been found in thirty-two towns and cities; but in all these towns and cities, except Somerville, Cambridge, Malden, Medford and Everett, it was either not numerous or very rare. In all the infested towns and cities, except the cities mentioned as nearest the centre, the webs of the moth found were only one or two seasons old. It was thus proved that the spread of the moth outside of Somerville, Cambridge, Medford, Malden and Everett had occurred almost entirely within the two years since the moth was first discovered in Somerville by agents of the Board.

It has thus been demonstrated that, had the \$10,000 been promptly granted when first asked for, the brown-tail moth might have been very nearly stamped out at that time, and its spread over all these towns prevented.

On November 29 nearly the entire gypsy moth field force (exclusive of a gang of wood cutters specially engaged for temporary work) was set at work destroying the brown-tail moth in Somerville. Work against the brown-tail

moth was continued throughout the region known to contain it until Jan. 1, 1899, when the appropriation was exhausted. The cost of this work being wholly sustained by a sum deducted from the gypsy moth appropriation, the gypsy moth work will be, of necessity, correspondingly delayed and slackened.

The brown-tail moth work was begun in Somerville, the city in which the moth was first discovered. This city has been from the beginning the most infested. The entire city was gone over, and the webs of the moth taken off the trees. The work was then carried into Cambridge, and most of the worst-infested parts of the city were gone over. Some similar sections of Medford and Everett were also covered; but there still remains much work to be done in Malden, Medford, Everett, Charlestown and Cambridge, in localities considerably infested, and where the brown-tail moth is likely to cause serious trouble unless an appropriation for the purpose of destroying it is made early in the season, before the caterpillars come forth from their webs.

For details of the year's work, reference is made to the report of Mr. E. H. Forbush, field director, which follows the report of Prof. C. H. Fernald, entomologist to the Board, both of which are presented herewith as a part of the report of the committee. The report of the field director also contains an account of the season's work and a statement in detail as to the present condition of the infested towns.

The committee hereby records its sense of obligation to Prof. C. H. Fernald, entomologist, and to Mr. E. H. Forbush, field director, for their highly valuable services.

The following is the financial report of the gypsy moth committee of the State Board of Agriculture for the year 1898:—

FINANCIAL STATEMENT FOR 1898,—GYPSY MOTH.

Balance on hand Jan. 1, 1898,	\$2,298 94
Appropriation for the year 1898, \$200,000, from which \$10,000 was set aside for preventing the spread of the brown-tail moth, leaving for the gypsy moth,	190,000 00
	\$192,298 94

Wm. R. Sessions, expenses, ...	\$15 00	
E. W. Wood, expenses, ...	21 91	
Augustus Pratt, expenses, ...	80 64	
F. W. Sargent, expenses, ...	66 92	
John G. Avery, expenses, ...	29 00	
N. I. Bowditch, expenses, ...	7 50	
S. S. Stetson, expenses, ...	55 98	
C. H. Fernald, expenses and remuneration, .	373 70	
E. H. Forbush, director, salary, ...	2,400 00	
Travelling expenses of director and men, .	1,234 20	
Teaming, livery and board of horses, . .	4,714 15	
Wages of employees, ...	157,833 54	
Rent of offices, storehouse and land, . .	474 40	
Supplies, tools, insecticides, printing, etc., .	19,174 94	
	\$186,481 88	
Balance on hand Jan. 1, 1899, ...	5,817 06	
		\$192,298 94

There are liabilities incurred for labor and supplies, due January 1, but unpaid, aggregating over \$4,000, so that the actual balance when these bills are paid should be less than \$1,800. This would all have been used, except for bad weather in December, when the men could not work.

FINANCIAL STATEMENT FOR 1898, — BROWN-TAIL MOTH.

Appropriation for the year 1898, ...	\$10,000 00	
Wages of employees, ...	\$9,847 56	
Travelling expenses, ...	49 37	
Supplies and printing, ...	102 03	
	\$9,998 96	
Balance on hand Jan. 1, 1899, ...	1 04	
		\$10,000 00

E. W. WOOD,
N. I. BOWDITCH,
AUGUSTUS PRATT,
SPRAGUE S. STETSON,
FRED W. SARGENT,
WM. R. SESSIONS,

Committee on the Gypsy Moth, Insects and Birds.

REPORT OF THE ENTOMOLOGIST.

To the Committee on the Gypsy Moth.

GENTLEMEN:—The gypsy moth is an exceedingly dangerous and destructive insect pest, for the reason that it is very hardy and prolific, and feeds upon nearly all kinds of vegetation.

POSSIBLE DAMAGE.

The question naturally arises, how much damage is this insect liable to do if allowed to spread over the Commonwealth of Massachusetts. The value of the agricultural products of this State, as given in the census for 1895, is \$52,000,000 in round numbers. About half of these products in value are at the mercy of the gypsy moth and may be entirely destroyed by it, while the remaining products will be indirectly affected to a greater or less extent. Although this insect has been uniformly destructive every year since our attention has been called to it, and, so far as we can learn, the same has been true since its first introduction, yet it is not impossible that in time, after it has spread over the State, it may become less destructive in some years than in others, just as now occurs in Russia, because of its natural enemies. We do not know that this would ever occur in this country; but, even if it should do so, a very conservative estimate of the average annual loss caused by this insect in this State alone is \$1,000,000. We have no data from which to estimate the number or value of the ornamental trees and shrubs in the parks and private grounds throughout this Commonwealth, and therefore no estimate is made of the cost of protecting them against the attacks of this pest. It is certain, however, that the annual appropriations thus far received for the extermination of the gypsy moth are a mere bagatelle compared with the amount that would be required to protect the ornamental trees and shrubs throughout the State of Massachusetts.

EXTERMINATION BY INDIVIDUALS IMPOSSIBLE.

A careful consideration of the attempts made by private individuals on their own grounds, as well as those made by the city authorities in Medford before the work was undertaken by the State, is quite sufficient to convince one that private enterprise can never exterminate this insect, nor can such enterprise prevent it from spreading rapidly over the State and country. I have never seen nor heard of a person who believed it possible for private individuals to exterminate this insect, even though the strictest laws were enacted to enforce the work.

EXTERMINATION BY THE STATE POSSIBLE.

The question arises whether it is possible for the State, through the Board of Agriculture, to exterminate this insect by the methods which are now being pursued. A few prominent persons have expressed very grave doubts of the possibility of extermination; but, after making thorough study and investigations of the entire work and carefully observing the methods and results, they have invariably reached the conclusion that it is possible to exterminate the insect in this Commonwealth.

During the summers of 1893-94 the gypsy moth committee invited nearly all of the economic entomologists in this country to visit the infested territory and make a critical examination of the work in all its details. Having done this, their reports were published in the report of the gypsy moth committee, and all spoke in the highest terms of the work and expressed the opinion that extermination of this pest is possible. These gentlemen being experts on this subject, their opinions are entitled to the highest consideration. In the winter of 1896-97 Prof. J. B. Smith, State entomologist of New Jersey, was employed by the Society for the Promotion of Agriculture to make a critical examination, with the special object in view of determining the possibility of extermination. In his report he expressed the opinion most emphatically that extermination is possible, provided sufficient appropriations are made for that purpose. During the summer of 1897 Dr. L. O. Howard,

entomologist to the Department of Agriculture in Washington, was sent here by the government to investigate this work. Many visits were made to the infested territory by Dr. Howard, and also by his assistant, Mr. C. L. Marlatt, who investigated the work in a very thorough manner, and their observations and conclusions were published in Bulletin No. 11, United States Department of Agriculture, Division of Entomology. Dr. Howard again visited the infested territory last fall, spending an entire week on the work, and in a private letter wrote me as follows : —

I shall not publish the results of my observations during my trip to Boston on October 7 to 14, unless called upon to do so. I have no hesitation whatever in informing you that, aside from the expedition which I took in your company to the gypsy-moth-infested regions of the town of Malden, I visited many other portions of the infested territory, and I feel that the results of the season's work have fully justified the prediction which I made on page 38 of my Bulletin No. 11. I cannot see how the most critical person could go over the ground now, especially if he had known the conditions of three years ago, without expressing entire satisfaction with the work which has been done and without being thoroughly convinced of the wisdom of the State's policy.

The prediction which Dr. Howard made in his bulletin, and to which he refers, is as follows : —

The writer believes that the condition of the entire infested territory at the present day is such that, with the prompt appropriation of the amount asked for by the committee at the beginning of the coming session of the Legislature, the work which will be carried on during 1898 will be of so effective a character that even those who most gravely doubt the policy of the State's efforts will be convinced of the efficacy of the work.

He further states that : —

A continuation of the appropriations for a few more years is unquestionably a necessity. Were the appropriation to lapse a single year, the work which has been done during the past six years would largely be lost. The \$775,000 already appropriated would have been spent in vain.

The Association of Economic Entomologists held its annual meeting in Boston last August, and the members took

that occasion to visit the infested territory and inspect the work on this insect. At a session held after this visit a committee was appointed to prepare a resolution expressive of the opinion of the members of the association regarding this work. The resolution is as follows :—

Resolved, That, the work of the gypsy moth committee in the State of Massachusetts having been inspected in all its details by a large number of the members of this association, and its methods of operation observed, it is our opinion that too much praise can not be bestowed upon those who are carrying out this important work. We consider that they have adopted the best methods yet devised for controlling the spread and ultimately exterminating this destructive insect; that their work, on the whole, has been remarkably successful, when the extensive area to be gone over and the insufficient or retarded appropriations are considered; and that ~~there~~ is every prospect of the accomplishment of the object of the committee,—the absolute extermination of the insect in the State of Massachusetts,—provided that funds sufficient for the purpose are placed at their disposal.

We consider that a stoppage of their work, or any serious reduction of it, would involve not only the loss of all that has been already accomplished, but would also permit this destructive insect to ravage the State and eventually spread over a large part of the Union, and cause an incalculable amount of injury to the whole community.

We trust that the Commonwealth of Massachusetts will continue to make early and ample provision for carrying on this work in a thorough manner for a few years longer, when we expect that the insect will have been brought under such control that a more limited expenditure will be sufficient.

CHARLES J. S. BETHUNE,*

HERBERT OSBORN,†

JOHN B. SMITH,‡

Committee.

Resolutions of a similar nature were adopted by this association at its meeting in Springfield, Mass., in 1895, in Buffalo, N. Y., in 1896, and again in Detroit, Mich., in 1897, and were published in its proceedings and also in reports of the gypsy moth committee.

* Rev. Dr. Bethune, Editor of the "Canadian Entomologist."

† Dr. Osborn, Professor of Zoölogy and Entomology in the Ohio State University.

‡ Dr. Smith, Professor of Entomology in Rutgers College, and State Entomologist of New Jersey.

We have therefore the opinion of every economic entomologist in America who has investigated the work, and they all without exception believe that extermination of the gypsy moth is possible, provided sufficient funds are furnished by the State and made available when needed.

COST OF EXTERMINATION BY THE STATE.

A very important question may now be considered, and that is, What will it cost the State to exterminate the gypsy moth? After a critical study of this insect, continued during the last nine years, I see no reason to change the general estimate of time and money that was published in the report of the gypsy moth committee for 1897, which was "an appropriation of not less than \$200,000 a year for a term of not less than five years, and then an appropriation of not less than \$100,000 a year for a term of not less than five years; after this an appropriation of perhaps \$15,000 a year for a period of five years."

In the spring of 1897 the Legislature appropriated only \$150,000, instead of \$200,000, the amount asked for; and the result was that no material gain was made towards extermination, so that the time given in the above estimate can be shortened by one year only. Last winter, however, \$200,000 was appropriated, but late in the session \$10,000 of this sum was assigned by the Legislature for work on the brown-tail moth; yet, with this reduced appropriation, such progress was made towards the extermination of the gypsy moth that I feel more than ever confident that this insect can be exterminated in the time and with the specific appropriations for each year indicated in my estimate given above, provided the appropriations are not delayed nor any portion of them assigned to other work than that on the gypsy moth.

A careful consideration of the various appropriations made since this work began, and the results obtained with each, shows that, when the amount asked for by the committee was appropriated and made available early in the season, very great progress was made in the work of extermination; but when the amount asked for was cut down or greatly delayed, there was little or no gain in the work. I

am very confident that enough money has already been spent in this work to have exterminated the gypsy moth, if it had been made available so that the committee could have used such sums as they needed and whenever it was needed.

I feel very strongly that it is time for the Legislature to settle the question whether the State is to work for the extermination of this pest, or not. If this is not to be done, then no further appropriations should be made; but, if it is to go on, what valid reason can any candid person give why the undivided opinion of all economic entomologists in America, who are the only experts in a case like this, should not be accepted, and the amounts estimated by those who are best informed and have given the closest study to every detail of the work be appropriated?

THE BROWN-TAIL MOTH.

This insect should be considered entirely by itself, and not grouped with the gypsy moth, if the question of its extermination is to be considered; for the reason that its habits are so totally unlike those of the gypsy moth that there is little or no economy in attempting to wage war against both insects at the same time. The action taken by the Legislature thus far would lead one to the conclusion that before a majority of our legislators can be convinced that this is so serious a pest that it should be dealt with by the State, it will have spread so far and wide over the country, if it has not already done so, that extermination will be impossible.

Fearing some such outcome as this, the committee have instructed the field director and entomologist, with such assistants as they may need, "to collect such information, both in this country and in Europe, in regard to the brown-tail moth, and make such experiments with the insect as may be useful to the committee in future dealing with the creature and necessary for the proper enlightenment of the public on the subject, with a view to publishing the said information if it may appear desirable."

Respectfully submitted,

C. H. FERNALD.

REPORT OF THE FIELD DIRECTOR.

To the Committee on the Gypsy Moth.

GENTLEMEN: — As it had been ascertained in 1897 that the moths were spreading from the badly infested woodland colonies in the central towns, thereby reinfesting the outer towns, the plan of work for the season of 1898 contemplated the destruction, at any cost, of the moths in these badly infested colonies. In pursuance of this plan, the 159 men who were in the employ of the Board January 1, were nearly all kept at work in the badly infested woodlands in Medford and Saugus. Three-fourths of the force worked through January in Medford. They were employed mainly in cutting decaying and badly infested trees, thereby reducing the number of trees to be inspected, climbed, scraped, burlapped, sprayed or otherwise treated during the summer work. Millions of moth eggs were destroyed by cutting and burning these trees, as well as by treating egg-clusters with creosote. While this work was going on in Medford, similar work was done during the cloudy or snowy weather in the Saugus woods. The work of inspection, cutting and burning was confined entirely to these towns and mainly to the worst colonies. There being no money available for the work after February 1, the entire force was laid off on that date.

THE WINTER AND SPRING WORK.

An emergency appropriation having been made early in February, the force was again put at work. It had been planned not only to destroy all the eggs possible in the worst colonies, but also to make an inspection of the territory in the central towns immediately surrounding those colonies. This work, which was begun in January, was followed up so that all of Saugus and most of Medford were

Plate II.



Workers burning over infested ground in Medford with cyclone burners, to destroy the pupæ and eggs of the gypsy moth. (See page 440.)

inspected. In both these towns extensions of old colonies were discovered, and, so far as was possible at that season, the moths were destroyed. A good deal of cutting and cleaning was done in Everett and Melrose during the month of February. All that was possible, with the limited number of men that could be hired with a small emergency appropriation, was done in the way of inspecting those towns where inspection was most needed. This was continued in the best weather until the snow had gone. When the weather was unfit for such work, the men were employed in thinning out the trees in infested woodland or cutting and burning undergrowth.

The emergency appropriation was nearly exhausted by March 11, therefore the force was laid off by relays until March 18. The most expert men were retained for a few days, and put into the worst known colonies, with a view to reducing the number of eggs of the moth there, so as to prevent any great outbreak should the Legislature make no provision for the work of the season before hatching time. The emergency appropriation being then exhausted, the entire field force was laid off from March 18 until April, when the appropriation for the season's work became available. The work of burning over the ground, so necessary in the worst-infested localities, which should have been done in April and early May, was much interfered with by the wet weather, which was almost continuous until after the eggs had hatched and the caterpillars had ascended the trees, when the burning had to be given up. All of this work was done that could be done under the circumstances. In the mean time, the force of men had been so rapidly increased that 340 men were at work before the end of April. The most expert of these were kept at work destroying the eggs of the moth in some of the worst-infested colonies (where they had been covered by snow during the winter), or inspecting territory in the search for eggs. The inexperienced men were employed in cutting and burning undergrowth in the infested woodland, burning over ground, spraying stone walls with oil and putting insect-lime upon the trees to prevent the young caterpillars from climbing them.

THE SPRING INSPECTION.

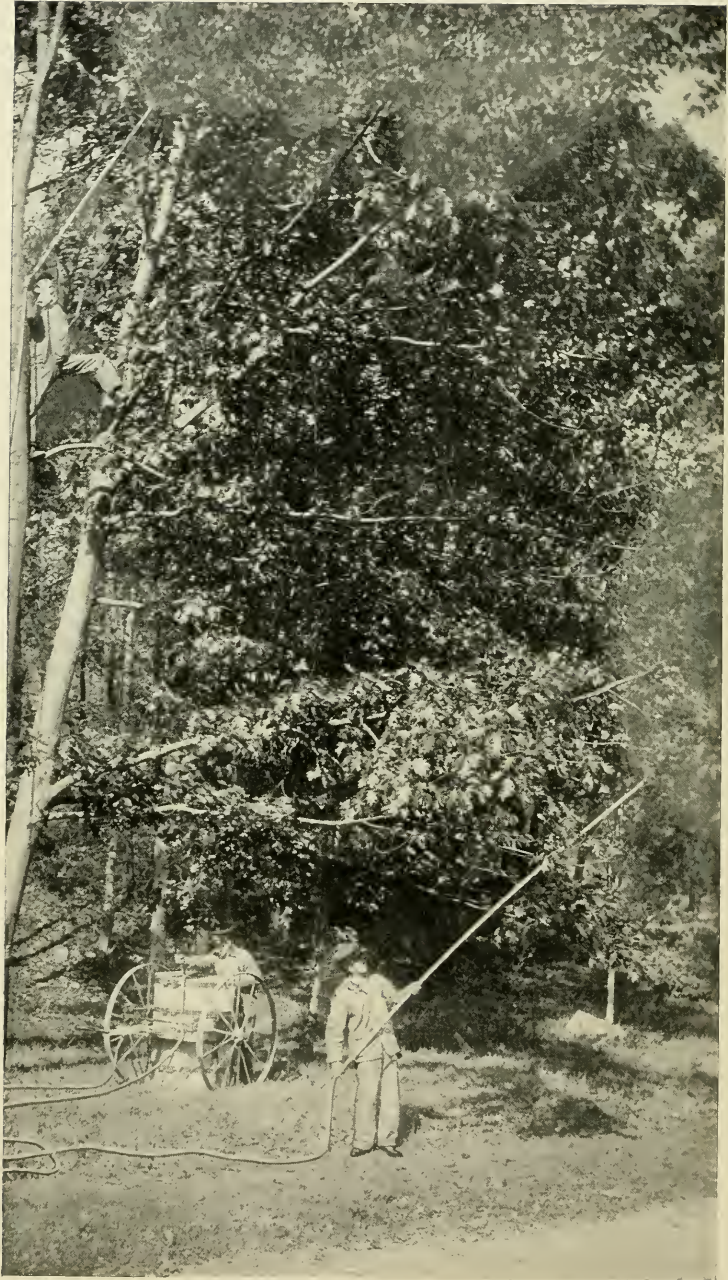
There were in the infested region considerable wooded tracts of land which for lack of money had not been inspected for the eggs of the gypsy moth for two or three years. In April and early May the examination of these wooded tracts was continued until hatching time. This was done to discover any new colonies, if such existed, and to prevent their increase and spread by destroying the eggs. A large tract in the Lynn woods was gone over in this way, while much work of the same kind was done in Swampscott, Salem, Wakefield, Melrose, Malden and towns in the Mystic valley. Small colonies were discovered here and there, and everything was done to insure their extermination.

SPRAYING.

The trees in the central colonies having been well cleared of moth eggs, there were still many eggs left on the ground which were not destroyed, owing to the impossibility of burning over this ground before hatching time. There was really no available method except burning which would stop the young caterpillars from climbing the trees and again re-infesting large tracts of woods, the trees in which had been cleared in the fall and winter at great expense. It was too wet in May to do much effective burning. Still, it was hoped that spraying would check attacks on the foliage. This was the only wholesale method that could be used until the middle of June, when the caterpillars began to cluster under the burlaps. Spraying was begun in the Medford woods and was continued for more than a month, whenever rain ceased to fall long enough to allow the foliage to dry. Wherever spraying with arsenate of lead could be done in dry weather it was very successful, destroying nearly all the caterpillars on low foliage and a large proportion of those on the tall trees.

Extensive preparations had been made for spraying—nozzles, hose, couplings, pumps and tanks having been invented in the preceding two years, and constructed in the machine shop at Malden especially for use in this work; but the almost continuous rainy weather prevented the full

Plate III.



Spraying for the gypsy moth. This plate shows improved spraying machinery in use.

employment of these devices, and did not permit of the actual use of all the insecticide purchased. The spraying machine, which, after three years experiment and improvement has been finally perfected and adopted in this work, is shown in the accompanying illustration. A detailed description of this machine and its appurtenances, together with cuts of the various novel devices connected with it, appears in the Appendix.

BURLAPPING.

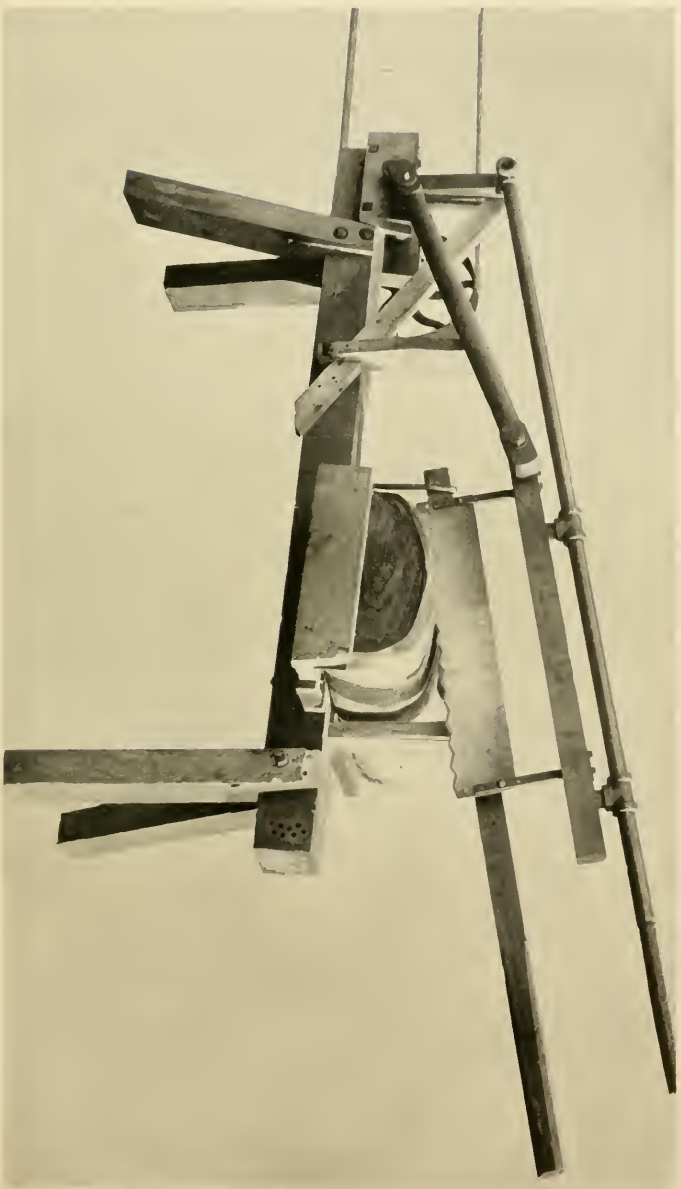
The work of the earlier part of the season having partially failed of its object on account of legislative delay and bad weather, it became necessary now to strain every nerve to prevent damage by the hordes of caterpillars which had hatched and ascended the trees. A larger amount of burlap was purchased than ever before, — about 54 bales, or 235,602 yards, — and 1,845,045 trees, included in nearly every colony in the infested region, were burlapped. In those towns which were believed to be most in danger from the distribution of the caterpillars from the central towns, nearly if not quite all the trees were burlapped. The results of the work of the past few years have furnished conclusive evidence that the work of burlapping for caterpillars, especially in forested lands, is by far the most effectual of any method yet devised for destroying the gypsy moth. All the work of cutting undergrowth, trimming, cutting and scraping trees, clearing up rubbish and much of that of burning over the ground contributes to one end, — that of the final destruction of the last gypsy moth caterpillar under the burlap. In the woods the main advantage of egg-killing in the fall and winter is to prevent the spread of the moth by greatly reducing the number of potential caterpillars which otherwise would hatch in the following spring. But it is the burlapping which has to be mainly depended upon to compass the destruction of the caterpillars which hatch from egg-clusters not destroyed during the cleaning, and to prevent the laying of more eggs the ensuing fall. To facilitate this work of burlapping, several implements have been devised. Burlap is bought by the bale and has to be cut into strips about a foot in

width. In the early years of the work, when comparatively little burlap was used, the cutting was done by hand, by dividing bundles of burlap with a sharp knife. This was a laborious and tedious task, and occupied the time of several men for many days. Experiment suggested the substitution of a hay knife in place of the ordinary butcher knife, and this greatly facilitated the cutting, saving considerable time. A large knife with a corrugated edge, which runs back and forth like a cross-cut saw, was then invented and attached to power by my assistant, Mr. E. C. Ware. This does the work of many men, and requires comparatively little attendance. The machine with a bundle of burlap in place for cutting is shown in the accompanying illustration.

When putting burlaps on the trees, it was found that the work was facilitated by making a hard roll of burlap, which was suspended by a string from the shoulder of the workman, being later unrolled, passed around a tree and cut as desired. Each man on receiving his strip of burlap would roll it up, pass a string through it and suspend it from his shoulder. This took the time of the men employed in putting on burlap. This delay has been done away with by the invention of a simple machine, which is shown on Plate V. By the use of this machine one man rolls all the burlap that is required.

Much time from the latter part of April until well into June was occupied in putting the burlap on the trees. As soon as this work was done it was time to begin killing the caterpillars which had gathered beneath the burlaps. At that date nearly every man employed by the Board on the gypsy moth work was engaged somewhere in killing caterpillars. But the greater part of these caterpillars were killed in Malden and Medford, and in places where the ground would have been burned over in the spring had the appropriation been made earlier. In these cases the caterpillars appeared in countless numbers. No attempt whatever was made to count them. Men were taken from the outer towns, from the storehouse and office to assist in killing caterpillars; and even then for a time the swarming insects seemed to gain, in spite of the slaughter. In a

Plate IV.



Perfected machine for cutting burlap.

Plate V.



Machine for rolling burlap.

week or two, however, the labor of over 300 men began to tell, and the number of caterpillars decreased so rapidly that comparatively few were left to pupate. The killing of the pupæ and moths was continued, until at the end of the season the egg-clusters were rare, as compared with those found in the same localities in the winter of 1897-98.

OIL BURNING.

There were some infested localities overgrown with underbrush (which could not be sprayed or otherwise treated early in the season), where the caterpillars later appeared in swarms. In some of these places the standing brush, on the appearance of the caterpillars, was burned by the use of the cyclone burner; in other places the undergrowth was cut down and fire was run over the ground. Where either of these methods was pursued, most of the caterpillars were immediately destroyed by the fire, and the few that escaped were driven to the burlaps on the trees and killed there. Most of this burning was done in Malden and Medford. In other infested localities, where the undergrowth could not be cut in season, the trees were burlapped and most of the caterpillars upon them were taken under the burlaps. Many of the survivors, however, retired to pupate in the undergrowth, dead leaves or rubbish upon the ground. On these pupæ the cyclone burner was used with deadly effect. In those large tracts of woodland in Malden and Medford which would have been burned over in the spring, had the appropriation been granted in season, burning was begun in July and continued through August and September, until the entire tracts were burned over. This burning, while extremely effective upon the pupæ of the gypsy moth, is also effective in destroying the eggs; and, as it was impossible to finish the work during the short season of pupation, it was continued after the eggs were laid. The intense flame of the cyclone burner destroys dead leaves, sticks and the like on the ground, and the eggs of the moth which are deposited on or among these and other objects. The great amount of this kind of burning to be done made it necessary to produce a machine which would burn over a

larger tract of territory than could be reached from one pump by the cyclone burner. For this purpose a large spraying tank, holding one hundred gallons of oil and supplied with a powerful pump, was used as a receptacle. This was attached to a long line of iron piping for a conductor of oil; to this piping lines of hose were coupled, at intervals. To each line of hose was attached an iron pole or nozzle, similar to that used on the cyclone burner. By this device one man could pump oil in sufficient quantity to supply six burners, which would cover all the territory for several rods from the tank. By means of the flexible hose a large strip of ground could be burned over, when the tank and piping could be moved forward and the operation repeated. Where the ground was not too rough, burning over large tracts of land was greatly facilitated by this improvement. This manner of burning is illustrated by Plate II., opposite page 434.

SPRAYING STONE WALLS AND STONE HEAPS.

It has been noticed, especially in the woods, that stone walls, ledges and stone heaps form the centres upon which the gypsy moth swarms and from which it spreads to the surrounding country. There are several reasons for this: (1) Stone walls are often flanked or overgrown with infested shrubbery, and the caterpillars, finding no adequate hiding-place within this growth, retire to the walls for refuge in the daytime. There they are protected in a measure from some of their natural enemies, and there later the moths lay their eggs, which are also more protected than in some other situations. (2) Where trees grow beside stone walls, as happens in woodlands, the larvæ, finding better protection in the wall than on the trees, retire to it, as in the preceding case. (3) In heavily infested woodlands the moths at times lay their eggs on leaves attached to the trees, oftener upon dead leaves on the ground. The autumn gales drive these leaves along until they catch on ledges, stone heaps or walls, where many of them remain until the eggs hatch. If the moths are left to themselves, therefore, each spring sees an increased brood issuing from these stony shelters. The economical treatment of eggs in walls, ledges and

stone heaps presents one of the greatest difficulties to be encountered in the extermination of the gypsy moth. The best method yet found for destroying the eggs in such places is that of spraying the stones with fuel oil. If this work be properly done at a season when the weather is not too cold, the oil spreads rapidly among the stones, penetrating the egg-clusters and destroying the life within the eggs. To treat thoroughly walls and ledges in this manner, it is necessary first to burn away with a cyclone burner the leaves around and among the stones, then spray the stones completely with the same machine. When carefully done this is the least expensive and most effective means known to-day of destroying the eggs in such hiding-places. This spraying was begun in July and continued until well into October. The greater part of it was done in Malden, Medford and other towns in the Mystic valley. Although several miles of stone walls and also many stone heaps and ledges were sprayed in this manner, the work was unfinished when the frost came. As it cannot be done to advantage in cold weather, it should be finished in the warmer days of March and April, 1899, before the eggs hatch.

THE FALL INSPECTION.

When the moths had laid their eggs, an inspection of all the burlapped trees was begun. Not only were the burlaps looked over and the eggs of the moth found beneath them destroyed, but the trees themselves were given a quick examination, and all the eggs in sight were killed with creosote. The most expert men were then employed in continuing the inspection (which had been ended only by the hatching of the eggs in the spring) of those towns which had not been examined entirely for two or three years. Fifteen towns, including most of those worst infested, were inspected during the summer or fall, partly in the burlapping season and partly during the search for eggs after the leaves had fallen from the trees. In some of these towns a few small new colonies were found, but in most cases they were found in season to prevent any wide distribution from them. While the inspection was going on, those

members of the force who were not expert at this work were employed in cutting decaying trees and underbrush, or destroying the eggs of the moth in the worst-infested localities. Large tracts of woodland in Medford, Malden, Winchester, Saugus and other towns were cleared by the brush cutters of the abnormal sprout growth due to the wet season, and were put in good condition for the work of 1899.

Much of the critical examination of the towns of the infested region is still undone, on account of the delay in making the appropriations. This sort of work requires the services of expert men. The number of this class to be obtained is comparatively small. For this reason the time lost in the spring could not be made up in the latter part of the year. But, if a sufficient appropriation can be made very early in 1899, thereby preventing delay and the loss of experienced men, this work can probably be completed before the eggs hatch. The men engaged in killing eggs in the worst-infested localities found very few where, in the spring, they had destroyed them by thousands. Still, many egg-clusters were found scattered through the woods in Malden, Medford and Melrose. Much work has been done there, but much remains to be done before the eggs hatch in the spring. It became evident during the season that, to secure the extermination of the moth in these woodlands of the central towns, a great amount of work would have to be done in 1899. Most of this woodland is of such value that the trees growing upon it cannot be cut, except such as may be removed where a judicious thinning is required. These trees, therefore, must be reckoned as an annual expense, for they must be burlapped, climbed and otherwise treated, until the moth is exterminated from these woods. For this reason it became necessary to reduce the number of trees in the infested woodlands of the outer towns, so that in 1899 they would require so little attention that the greater part of the force could be concentrated in the woodlands of the centre. A gang of wood-choppers was organized and put at work cutting underbrush and thinning out the woodland in the central towns, until the great snow storm of November 26 made thorough work of this sort impossible. These men

were then transferred to the woodland colonies in the outer towns along the Mystic valley. There much cutting was done. Comparatively little work, therefore, will be required in this region another year. In most cases the woods in the outer towns are maintained by their owners merely for the value of the trees as cord wood. This wood is periodically cut by the owners for their own profit. Where this is the case, it is economy for the Board to cut it a few years sooner than otherwise it would be cut, as the expense of inspecting and caring for the trees for three or four years would be much greater than that of cutting off the wood.

EXAMINATION OF EXTRALIMITAL TOWNS.

Several expert men were detailed to make an examination during June and July of towns outside the infested region. At that season, when the moths swarming in numbers in a spot have reached the height of their destructiveness, their injury to the foliage may be observed readily from the hill-tops or from any point of vantage. Men supplied with powerful glasses examined the territory within a wide arc about the infested region. No indication of the moth was found, however, except in Manchester. The condition of this town is treated of on page 453. In pursuance of a plan suggested by Dr. L. O. Howard, entomologist to the United States Department of Agriculture, in his report on the gypsy moth, made to Congress in January, 1898, a bulletin, descriptive of the gypsy moth and illustrative of its ravages, has been prepared and is being distributed under my direction. It is intended to distribute this bulletin from house to house in all the towns adjacent to the infested region. Distributors are to call particular attention to the danger which would threaten vegetation should the pest obtain a foothold beyond the known infested region. They are also to make such examination for the moth as can be made while they are engaged in the distribution of the bulletins, and to investigate any case of supposed gypsy moth infestation of which they may hear. It is expected and believed that, if any large colonies of the gypsy moth now exist outside the region known to be infested, they will be discovered by

the kind of work outlined above. It is desirable to begin to maintain a thoroughly organized, careful examination of these outer towns, so that, if any small colonies exist, they may be discovered and destroyed. No systematic work of this kind was attempted in 1898, because of the enormous amount of work to be done in the central infested towns.

SUMMARY OF YEAR'S WORK.

In making this summary there can be given only the figures which represent such proportion of the year's work as can be tabulated accurately. The figures giving the number of the different forms of the moth found which appeared in the tables of the reports previous to that of 1898 were taken annually at considerable trouble and expense. They have been omitted in this and the previous annual report, as it has been decided to save the time and labor necessary to keep through the year the accurate accounts required to make up the summary. The reason for this omission was explained in full on page 25 of my report of January, 1898. The trees were cut mainly on about 2,000 acres of land on which the brush was cut and burned. The acreage given as cut over (2,933 acres) may give a wrong impression; for, although this number of acres was actually cut over either in the spring or fall, this acreage included nearly 1,000 acres on which the sprouts were cut early in the spring and again late in the fall.

Work Done.

Trees inspected, ...	12,514,240
Trees banded with insect-lime, ...	4,752
Trees burlapped, ...	1,845,045
Trees sprayed, ...	23,440
Trees cut, ...	376,468
Trees trimmed, ...	175,629
Trees scraped, ...	1,529
Trees in which holes were covered, ...	2,355
Buildings inspected, ...	10,107
Buildings infested, ...	801
Fences inspected (rods), ...	55,909
Fences infested (rods), ...	818
Stone walls inspected (rods), ...	11,029

Stone walls infested with eggs (rods), ...	540
Stone walls burned (rods), ...	1,505
Stone walls sprayed (rods), ...	2,487
Brush cut and burned over (acres), ...	2,933
Ground burned over with oil (acres), ...	173
Ground burned over without oil (acres), ...	271
Ground sprayed with oil (acres), ...	4

Number of Employees in 1898.

Jan. 1-Jan. 8, ...	159	July 4-July 9, ...	333
Jan. 10-Jan. 15, ...	164	July 11-July 16, ...	332
Jan. 17-Jan. 22, ...	184	July 18-July 23, ...	343
Jan. 24-Jan. 29, ...	204	July 25-July 30, ...	349
Jan. 31-Feb. 5, ...	30	Aug. 1-Aug. 6, ...	345
Feb. 7-Feb. 12, ...	166	Aug. 8-Aug. 13, ...	334
Feb. 14-Feb. 19, ...	203	Aug. 15-Aug. 20, ...	335
Feb. 21-Feb. 26, ...	198	Aug. 22-Aug. 27, ...	315
Feb. 28-March 5, ...	206	Aug. 29-Sept. 3, ...	317
March 7-March 12, ...	204	Sept. 5-Sept. 10, ...	283
March 14-March 19, ...	100	Sept. 12-Sept. 17, ...	290
March 21-March 26, ...	6	Sept. 19-Sept. 24, ...	288
March 28-April 2, ...	56	Sept. 26-Oct. 1, ...	286
April 4-April 9, ...	206	Oct. 3-Oct. 8, ...	266
April 11-April 16, ...	269	Oct. 10-Oct. 15, ...	267
April 18-April 23, ...	322	Oct. 17-Oct. 22, ...	261
April 25-April 30, ...	341	Oct. 24-Oct. 29, ...	263
May 2-May 7, ...	338	Oct. 31-Nov. 5, ...	265
May 9-May 14, ...	363	Nov. 7-Nov. 12, ...	274
May 16-May 21, ...	361	Nov. 14-Nov. 19, ...	318
May 23-May 28, ...	359	Nov. 21-Nov. 26, ...	348
May 30-June 4, ...	355	Nov. 28-Dec. 3, ...	289
June 6-June 11, ...	357	Dec. 5-Dec. 10, ...	415
June 13-June 18, ...	354	Dec. 12-Dec. 17, ...	524
June 20-June 25, ...	356	Dec. 19-Dec. 24, ...	431
June 27-July 2, ...	344	Dec. 26-Dec. 29, ...	423

The figures given above do not represent the full number of employees, but give only those actually at work each week. The force reached its maximum of 524 men in December, when a large number of extra men were hired on the brown-tail moth work. As the act setting aside \$10,000 for this purpose went into effect too late for it to be of any service in the spring, the money was left in the treas-

ury until December, when, the leaves having fallen from the trees, the webs of the brown-tail moth could be most readily seen and destroyed.

FALSE ALARMS.

The non-infested towns which have been visited because of complaints received are : —

Cottage City, Mass.	Hopkinton, Mass.	Falmouth, Mass.
Concord, Mass.	Hudson, Mass.	Wilmington, Mass.
Edgartown, Mass.	Quincy, Mass.	
Groton, Mass.	Topsfield, Mass.	Wallingford, N. H.

No gypsy moths were found in any of these towns.

PRESENT CONDITION OF THE INFESTED REGION.

The appropriation made available for use against the gypsy moth in 1898 being nearly the full sum recommended by the Board, it was possible to go over a greater part of the infested territory than in any previous year; therefore a more accurate report in detail of the condition of the infested region at the end of the season can be given than ever before.

In seven of the formerly infested outer towns no gypsy moths were found in 1898. In five others, from one to three small spots only were found infested, and in these no eggs were found in the fall inspection; in the other outer towns comparatively few moths were found. There are five towns, which may be termed the "central towns," that are still generally infested; but, as a whole, their condition was greatly benefited by the work of 1898.

The gypsy moth was found last year in one town outside, but contiguous to, the region previously known to be infested. The description of the condition of this town (Manchester) is given in its proper place.

The condition of the infested woodlands, the handling of which has been regarded as the most serious part of the problem of extermination, is now much better than at any time since 1893. The woods of the Mystic valley are no

longer infested to any serious extent. About one thousand acres of woodland were generally infested there in 1896, portions of it being in as bad condition as anywhere in the whole infested region. In the Saugus woods, where another thousand acres were infested at that time, the moths are now becoming very scarce. Even in the Middlesex Fells region they are not now generally numerous.

PLACES FORMERLY INFESTED IN WHICH NO GYPSY MOTHS
WERE FOUND IN 1898.

The gypsy moth was not found in 1898 in Beverly, Brighton, Danvers, Charlestown, Nahant, Reading and Waltham. As it is possible that straggling caterpillars have been disseminated to some of these places from the badly infested central territory, they should all be examined in 1899; and, even if no gypsy moths are then found in them, they should still be examined occasionally thereafter. Marblehead cannot be included in this list, as a single caterpillar was found there in the summer of 1898.

THE OUTER TOWNS.

Under this heading those towns are mainly considered which lie between the central towns of the infested region and its border. They are the towns which are now believed to be little infested, their condition varying from that of Marblehead, in which only one caterpillar was found in 1898, to that of Belmont, where numbers were found. The condition of each of the outer towns is given below : —

Arlington.

The condition of Arlington was quite accurately determined by the examination of the winter of 1897-98 and by the work of the summer of 1898. Nearly if not quite all the old colonies in the residential part of the town appear to be exterminated. The woodland colonies have been greatly reduced, and are now, with perhaps one or two exceptions, very nearly exterminated. In all the woodland colonies on the north side of the town only about seventy

egg-clusters were taken in the fall of 1898. In two woodland colonies on the south side of the town near Arlington Heights quite a large number of caterpillars was taken. These colonies have been thoroughly looked to, and should be in excellent condition in 1899. A few single caterpillars were picked up here and there under the burlap through the village and along the main streets and avenues. Most of these had evidently been brought in from Medford. Seven men were able to do all the work necessary in Arlington during the summer of 1898, where from a dozen to thirty were formerly employed. Considerable cutting away of underbrush is necessary in some of the infested woodland, to ensure extermination there; otherwise, little remains to be done in the town except to follow up by burlapping and inspection the good work already accomplished.

Belmont.

Belmont is not believed to be now anywhere badly infested; but there are several colonies where the underbrush has not been cut, and where the moths are believed to have spread. Furthermore, no thorough inspection of the whole town, including the woodland, has recently taken place. The work of clearing out the underbrush in infested localities was begun in November, and a thorough examination of the town was to have begun about December 1. The snow which fell in the great storm of November 26 (much of which has since remained on the ground) has prevented the completion of this work. It is impossible, therefore, to give an accurate report of the condition of the town at this time. It is well known that many of the colonies found in the early years of the work have been exterminated, as nothing has been found in them for several years. All the known colonies were burlapped and well attended through the summer. The number of larvæ found in 1898 was probably less than the number found in 1897, but in some cases they were more widely scattered. All the colonies now appear in good condition. It is now necessary to clear up the underbrush in the woodland, cut and burn brush along stone walls, cover the holes in trees in infested localities, as well as give the entire town a thorough inspection.

Boston.

At Orient Heights, East Boston, a number of caterpillars were taken during the burlap season. Four or five caterpillars were taken by burlaps in Dorchester and Roxbury. Elsewhere in the city nothing was found except in South Boston, which was gone over early in the season, and only a few trees found infested. These were burlapped, and a few caterpillars taken during the summer. All the known colonies in Boston, therefore, are well accounted for. But the whole city should have a thorough inspection, as it is quite probable that, from its nearness to the infested centres and the vast amount of travel and traffic to and fro, the moth may have obtained a new foothold somewhere within the city limits.

Brookline.

Two considerable moth colonies were found in Brookline in 1896. Since that time the town has been thoroughly inspected, and no moths have been found except within the vicinity of these two localities. The Crafts colony, situated near the Newton line, appears to have been exterminated. This place was carefully inspected both in the spring and fall of 1898, and a much larger number of burlaps put on than in 1897, covering a larger territory. The country in the vicinity was also carefully searched, yet no trace of the gypsy moth was found.

In the Schlesinger colony, situated more than a mile from the Crafts colony, and on the southern side of the town, a few larvæ were found here and there in 1898, both on the Schlesinger and adjoining estates. As the burlap season advanced, it became evident that in the search for eggs at least one or two concealed egg-clusters must have been overlooked. The greatest care was taken to rid the neighborhood of the gypsy moth, the burlaps being turned every day, and the most careful search of the vicinity made in the fall. A wide circle around the infested spot was also inspected, but no trace of the gypsy moth found. It is hoped that the moth has now been entirely exterminated from this locality, but it should be carefully watched, and the whole town should have another inspection as soon as possible.

Burlington.

Only two localities were known to be infested in Burlington in 1897. In one of these a single pupa was found in 1898, in the other a few caterpillars. There is some possibility that a few caterpillars may be found another year, owing to the nearness of a Woburn colony to the Burlington line. Every effort, however, has been made there to exterminate the moth. A large tract of woodland in northern Burlington should be inspected in the near future.

Cambridge.

The present condition of Cambridge is excellent, most of its territory having been inspected within the year. Very little new infestation was found, with the exception of single caterpillars picked up here and there under the burlaps, or an occasional lone egg-cluster. An effort was made in 1898 to put Cambridge in the best possible condition as regards the gypsy moth. It was intended in the fall inspection to clear of eggs every known infested colony, but this work was interrupted by the great snow storm of November 26. It is hoped that this work can be finished during the winter. The only region in Cambridge in which the gypsy moth was found in 1898 in any numbers lies between Harvard Square and Mt. Auburn Cemetery on the one side and Fresh Pond and Massachusetts Avenue on the other. There are in this part of the city many trees and much shrubbery, highly valued by the owners, and requiring most careful treatment for the eradication of the moth. The only considerable colony found in the city in 1897 appears to have been practically wiped out by the work of that year. It now remains to inspect that portion of Cambridge which was not inspected last year, and to destroy the remains of the colonies where the moth still lingers. Nearly all the old colonies where the moths were so numerous in the early years of the work have been exterminated. Each year the moths are accidentally brought in from other towns to the section around Harvard Square, and about Commencement time two or three caterpillars or pupæ are picked up under the burlap on the college grounds. This can be prevented only

by the destruction of the moth in Medford and other central towns. Cambridge may now be considered as one of the outer towns of the infested region, in which the extermination of the moth is well under way. But considerable work will be required here for several years.

Chelsea.

The older colonies in Chelsea appear to have been exterminated. No new colonies of any size were found during 1898, yet a number of caterpillars were taken here and there under the burlaps. These caterpillars were evidently brought in from Malden and Everett, where they were very numerous in some localities for about a month during the summer. If this reinfestation can be prevented by the destruction of the moth in the central towns, Chelsea can be readily freed from the gypsy moth in a few years. As the city was thoroughly burlapped and the trees examined when the burlaps were removed, and as this has been done for two years in succession, it will hardly need a further examination, but should be burlapped again in 1899.

Lexington.

The good condition of Lexington, as shown in the last report, has been continued and improved. There appears now to be no serious gypsy moth infestation in the town. The number of caterpillars taken under the burlaps in 1898 was insignificant, except in woodland in the south-eastern corner of the town, which was formerly as badly infested as any in the gypsy moth region. The moths have been greatly reduced here from year to year. Some of the colonies have been entirely exterminated and others are now on the verge of extermination. For instance, in one colony in which 1,962 larvæ were taken under burlap in 1897, only 353 were taken in 1898. In another, where 57,444 caterpillars were taken in 1897, only 8,386 caterpillars were taken in 1898. The present policy of thinning out the trees in these woodland colonies will greatly assist in extermination, as well as reduce the amount of work necessary to secure it. A thorough search of the entire town is now in progress. In this

search a few egg-clusters have been discovered in the woods, but no large colony is believed to exist anywhere within the town limits.

Lincoln.

A full account of the finding of a badly infested locality in Lincoln was given in the report for January, 1898. When this colony was found, July 13, 1897, about half an acre of woodland had been stripped by the caterpillars, and some of the trees were already dying; over an acre and a half more of grass, shrubbery and other plants had been stripped or destroyed. The work of 1897 so reduced the moths at this point that comparatively few were found there in 1898; but eggs were found scattered to a distance of half a mile from this centre. Further examination in the spring and summer of 1898 showed that the moths had been scattered chiefly during 1896 and 1897 over about a thousand acres, mostly woodland. As this distribution had been recent, the moths were not numerous anywhere excepting in the immediate vicinity of the colony found in 1897. Here they were found in 1898 in numbers along the stone walls and through the woods. The walls were treated in the following manner. The brush along one side of a wall was burned, thus destroying most of the caterpillars on that side and driving the rest to the other side of the wall, and the next day the brush on the other side was burned. In the woods the brush was cut and left on the ground to dry. Then a fire was run through it, and all not entirely destroyed by the fire was picked up and burned. This was done at a time when the caterpillars were mainly on the undergrowth. This killed most of them. The same day the few trees injured by fire were cut down and the other trees burlapped. The burlap was then followed up, with the result that most of the caterpillars were taken under the burlaps within twenty-four hours after burning. In some places where the caterpillars were most numerous the ground was burned over with oil. The woods were burlapped in all directions from the central colonies to a point beyond where any caterpillars were found. More than 94,000 trees were inspected, and 16,556 trees were burlapped. A few caterpillars were found here and there

throughout the burlapped area. These burlaps were attended with the utmost care, and very few egg-clusters were found in the fall. As a few had been found in 1897 in Weston, just over the Lincoln border more than 3,000 trees were burlapped in that town. No egg-clusters were found in the fall inspection in Weston. Only one egg-cluster was found on the trees in the original colony in Lincoln, where hundreds of thousands of caterpillars were destroyed by fire the year previous. It is intended during the winter and before the eggs hatch in the spring to take out all the rubbish and worthless trees in the infested woodland in Lincoln, so that the burlaps may be doubly effective in 1899. A part of this work has already been done. If the necessary work can be done here in 1899, the gypsy moth should be very rare in Lincoln at the end of that year.

Lynn.

Very few gypsy moths were found in the city of Lynn in 1898. Greater care than ever was taken with the work in the Lynn woods. Nearly twice as many burlaps were put on in these woods as were used in 1897, but the number of caterpillars found was very much less. Considering the nearness of Lynn to the Saugus woods, it will be wise to inspect thoroughly at an early day the whole city, including the woods.

Lynnfield.

As all the old colonies in Lynnfield found prior to 1893 were exterminated several years since, most of the work done here in 1898 was confined to those colonies found later in the woods. In these the moths appear to be nearly though not quite exterminated. It is now time to give the whole town another thorough inspection.

Manchester.

In July, 1898, notice was sent to the director's office that the gypsy moth was doing much injury in Manchester. At this time the gypsy caterpillars had already stripped the foliage from trees in an orchard, and were spreading through a strip of salt marsh to the woods beyond, eating the salt

marsh grass as they went. The work of destruction on the trees was very complete, as the caterpillars had eaten not only the leaves but the mid-ribs, stems and even the buds of the newly forming foliage. The agents of the Board were soon on the ground attacking the caterpillars with fire. The ground in the immediate vicinity was burned over. A small building under which the caterpillars had sought refuge was burned, and the swarm was stamped out at once. Then the work of finding the scattered caterpillars was begun. From the size of this colony, it seems plain it must have been established in Manchester for several years, and it would have been found long since had means enough been provided. Its presence there may be accounted for by the fact that a man who had business in the vicinity lived in the infested region, and had continually driven back and forth for years. The trees in the near-by village were burlapped, as well as those in the neighboring woods. As the inspection of the town progressed, not only were the caterpillars found under these burlaps, but single egg-clusters were later found here and there in the estates of summer residents along the shore. As delivery wagons were accustomed to stand near the infested trees before our work began there, and as it was noticed that many caterpillars dropped upon such wagons and were even carried by some of them into the estates before mentioned, it is most probable that the distribution of the gypsy moth in Manchester was mainly brought about in this way. The destruction of the colony should prevent further dissemination of the moth in Manchester or near-by towns, but the entire town and all the surrounding region should have now a thorough inspection. This inspection has already begun.

Marblehead.

Only one gypsy moth caterpillar was found in Marblehead in 1898, and that one at the only locality where the moth was found last year. If by a clearance of the central towns the moths can be kept from spreading again into Marblehead, it will need only an occasional inspection to make sure that no seed is left.

Peabody.

From all or nearly all of the old colonies known in Peabody up to 1898 the moths appear to have been exterminated; but, as the town as a whole had not had a thorough inspection for nearly three years, the opportunity was taken in 1898 to go over it. This inspection was in progress and the greater part of it finished when it was stopped by the great snow storm of November 26. In 1897 a colony of some size was discovered in the centre of the town; in the summer of 1898 another was discovered near the Salem line. The inspection of the fall of 1898 revealed the fact that single caterpillars had been distributed widely from these two colonies, and that from them one or two smaller colonies had already become established. The colony found in 1898 was so situated that the infested trees, from which a great number of larvæ were taken, hung over a lane which was much travelled by delivery teams as a short cut from one part of the town to another. These colonies were discovered just in time to prevent reinfestation of the whole region. The greatest care has been taken to stamp them out; but considerable work in this town will now be necessary for several years. Had the appropriations been sufficient, Peabody would have been thoroughly examined two years ago. These colonies might have been found, and all the spread which has since occurred might have been prevented. The inspection of Peabody should be finished as soon as the snow is gone.

Revere.

Nearly every tree in the town of Revere was burlapped in 1898. The burlap was not as well attended to in Revere as in some other towns, because of the necessity of a great amount of work in Malden to prevent the caterpillars from scattering into towns to the north. A few caterpillars were taken here and there under burlap, but the principal examination of the bands was not made until the eggs were being laid in the fall. Single egg-clusters were found scattered here and there, most of them having been deposited by moths which had developed from caterpillars brought into

the town during the summer from Malden or Everett. The condition of the town continues excellent, though not much improved over that of last year. So soon as the moths in Malden and Everett are destroyed, but not before, Revere can be cleared of the pest. The summer travel toward the beach may be expected to continue carrying moths into the town so long as there are many in Malden, Medford and Everett.

Salem.

A thorough inspection of the entire city of Salem, which was made during the fall, indicates that the moths were exterminated from the residential part of the city by the work of 1897. Some still remain in the partially wooded tract, known as the Salem Pastures, which are kept infested by people continually driving cattle into them from the direction of Lynn and Saugus. The fall inspection has shown here and there a few egg-clusters in the Pastures; it has also shown a few recent clusters scattered singly through the centre of the town. All the conditions indicate that these have been distributed by travel from the colonies in Peabody near the Salem line. Every egg-cluster found has been destroyed; but there still remains work to be done in the Pastures, part of which cannot be undertaken until the snow has disappeared.

Somerville.

The condition of Somerville still remains good. A very few stray larvæ have been found in some of the Somerville colonies, and also in some places not heretofore known to be infested. Most of these were probably brought in from Medford in various ways during the season. For instance, in Tufts College grounds, situated on the Medford and Somerville line, a few single caterpillars are annually picked up under the burlaps about Commencement time. In a search made during the spring a few small new colonies were found before the eggs hatched. There were only two localities where the caterpillars were found in numbers. These were carefully treated, and very few moths have been found there since. The entire city was inspected in the fall of 1898, and all egg-clusters found

were destroyed. There will be little difficulty in exterminating the gypsy moth from Somerville when the large colonies in Medford have been exterminated, but so long as these exist, Somerville is constantly menaced by danger of reinfestation.

Stoneham.

In Stoneham village a very few caterpillars were found in the summer of 1898 in some of the old infested places. Many of these were stragglers picked up by the use of the burlaps. In this village there are several localities where present or former employees of the Metropolitan Park Commission live, and these places have probably become infested by the hauling of infested wood from the park to these men's homes. Comparatively few larvæ were found here. More were found on the streets leading from the Middlesex Fells to Stoneham than anywhere else. All signs indicate that the distribution of the moths from the Middlesex Fells into Stoneham village is nearly at an end.

Southern Stoneham, which comprises mainly woodland of the Middlesex Fells, appears to be in much better condition than last year. Much of this woodland was burlapped. In a few colonies no moths were found, and in some of the others a very few larvæ. In none of these colonies were as many taken as last year, although the number of burlaps put on was greater. Along the Medford line the caterpillars were found coming over into Stoneham in considerable numbers, but the work of the summer of 1898 in Medford should prevent this happening another year.

Swampscott.

There are but three localities in Swampscott in which any form of the gypsy moth was found in 1898. Nothing was found in the fall inspection. This report is very encouraging, when we consider that Swampscott contained at one time more gypsy moths than any other town in the infested region. Considering its nearness to Lynn and Saugus, it would be surprising if another inspection of the town does not reveal some infestation; but it is believed that no colony of any size can now exist there.

Wakefield.

It was stated in my last annual report that an examination of the central part of Wakefield was made in November, and two egg-clusters were found. This examination was continued, and after the date of that report a few egg-clusters were found in several places in other parts of the town. This indicated that the moths had begun to spread into the village from the badly infested woods in Saugus and Medford. Very little work was done in Wakefield from 1894 until 1898, except in localities known to be infested. Early in 1898 the infested woodland in Wakefield adjoining the Saugus woods was cleaned up; many of the trees were cut, the underbrush cut and burned, and the burlaps carefully attended to all summer. The gypsy moth appears now to be very nearly if not quite extinct in that locality. An inspection of the entire town of Wakefield was begun in December, 1898, and the greater part of the town has already been covered. A few egg-clusters have been found here and there. If an appropriation can be made early in 1899, this work can be finished, and all these small infested spots can be cleared of the gypsy moth.

Watertown.

Gypsy moth caterpillars were again found in Mt. Auburn cemetery in 1898. They are very likely to occur there so long as the moths are found in any numbers in any of the central towns, for there is much travel from all these towns to the cemetery during the time of the year when the caterpillars are on the foliage. There is another locality where a few egg-clusters appeared. Elsewhere no gypsy moths were found in Watertown during the year.

Winthrop.

Winthrop appears to have been more than once practically cleared of the gypsy moth. The trees in the town were nearly all burlapped this year, and a caterpillar was picked up here and there. This indicates that the caterpillars have again been brought into Winthrop by summer travel from Everett, Malden and Medford. A few caterpillars escaped

the burlapping, and therefore a few eggs were found in the fall. The town has been gone over thoroughly, and no moths are now known to exist there.

Woburn.

The residential and business portions of Woburn appear to be in at least fifty per cent better condition as regards the gypsy moth than they were in the fall of 1897. The bad colonies are either entirely or nearly wiped out. The single scattered caterpillars found under burlaps this year were much fewer than last year. There were some places where it was necessary to do away with the hiding-places of the caterpillars by cutting brush and covering holes in trees. A few larvæ were taken during the summer in the older woodland colonies of Woburn, and in some of them a few egg-clusters were found. All the necessary work to put these colonies in good condition for 1899 is now being done. All the woodland in the town should be thoroughly inspected before the eggs hatch in the spring.

THE CENTRAL TOWNS.

Under the head of central towns are included those in or near the centre of the infested region which are most infested. Although these towns are all generally infested, there is considerable difference in their relative condition, Winchester being probably now the least and Medford or Malden the most infested.

Melrose.

The northern portion of Melrose is in excellent condition. Much of the woodland in the south-western part of the town which is contained in the Middlesex Fells Reservation is infested, and the moths have probably spread there since a year ago. The worst woodland colony in the southern part of the town has been well cleared up and the moths there greatly reduced. Owing to the necessity of using nearly all the force employed in this division in Malden for a large part of the summer, Melrose was somewhat neglected, and, as a result, is probably as a whole in very little better con-

dition than in 1897. The whole town, woodland and all, needs a thorough inspection. In many of the colonies the undergrowth should be cleared out and everything put in shape for the work of another summer. If the appropriation for the year 1899 is not delayed, this work can be done before the eggs hatch. Unless this is done, the work in Melrose during the summer of 1899 will be greatly handicapped.

Saugus.

For the first time since the beginning of the work of exterminating the gypsy moth it is possible to report accurately the condition of Saugus. For several years the wooded section of north Saugus was more generally and thoroughly infested by the gypsy moth than any other locality in the infested region. The inspection of this section, made in the winter of 1897-98, and the cleaning up of the rubbish and dead wood which followed, fitly supplemented the work of 1897; so that for the first time it can be said with truth that gypsy moths are rare in Saugus, even though the whole town may still be regarded as infested.

A comparison of the number of caterpillars found in 1897 in several colonies with the number found in 1898 shows how the work of the two years has told. In one colony, from which 669,324 caterpillars were taken in 1897, only 10,800 were taken in the summer of 1898. In another, in which 745,934 were taken in 1897, only 73,000 were taken in 1898. In 1897 there were taken in north Saugus woods, under 122,000 burlaps, 3,522,783 caterpillars; in the summer of 1898 there were taken under double the number of burlaps only 297,000 caterpillars. At the end of the season very few egg-clusters were found. There is now little danger of such a spread from Saugus into towns surrounding as in past years. It will require, however, quite as many men thoroughly to attend to the Saugus woods in 1899 as it did in 1898. There is still a large amount of undergrowth to be cut out, and that which already has been cut must be kept down. It will be necessary to add still more to the number of burlaps, and although the number of caterpillars taken will probably be very small,

as compared with the number taken in past years, it will require a great deal of labor to exterminate the gypsy moth from these woods.

Medford.

Owing first to the delay in making the appropriation and finally to the almost continuous wet weather which followed, it was impossible in the spring of 1898 to burn over the ground in many of the worst-infested colonies in the Medford woods. This was particularly unfortunate, as the result showed that the eggs of the moth were very numerous among the dead leaves, loose rocks and other rubbish on the ground. A great deal of money was expended here in burlapping and spraying in 1897, and also in destroying the eggs on the trees. This work occupied, until snow came, all of the time of the few men whom it was possible to employ here with the reduced appropriation made in 1897, so that it was impossible to burn over the ground in the fall. As it was also impossible, for reasons previously given, to burn over the ground in the spring of 1898, the young caterpillars came up from the ground in large numbers; and, as a consequence, notwithstanding all the work done in these woods in 1897, the caterpillars were more numerous in 1898 than in 1897. It was necessary to keep 100 men at work in Medford all summer killing the caterpillars. They were killed in such enormous numbers that an estimate could hardly be made of the number destroyed. The result of this work, however, is that there is now hardly one egg-cluster on the trees, where there were thousands in 1897. The work of burning over the ground, which, for reasons given above, could not be done in the spring, was begun in July while the caterpillars were pupating. The ground was burned over with oil-spraying machines. As much of this work came within the limits of the Metropolitan Park reservation, every care was taken to preserve the trees, especially the pines.

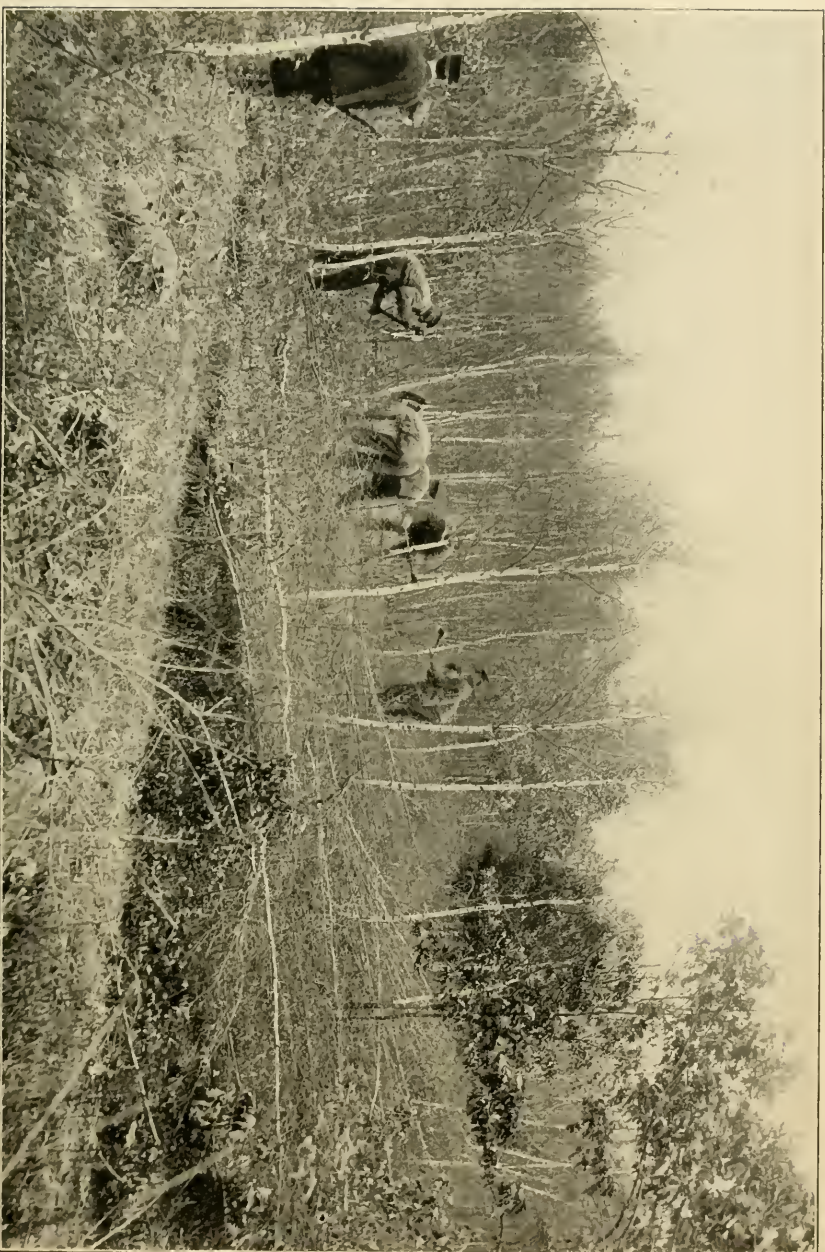
The value of the work done during the season in Medford is indicated by the difference between the number of egg-clusters killed in 1897 and those found in 1898. The figures show that there was a decrease in the various colonies of

from 80 to 99.9 per cent. In one colony, where in 1897 41,843 egg-clusters were killed, in the fall of 1898 only 43 were found. In another colony 58,390 egg-clusters of 1897 were killed, while in the fall of 1898 only 18 were found.

Notwithstanding the great improvement in the condition of these woods, caterpillars will probably be found scattered through them in the spring of 1899. Nearly all the Medford woods, therefore, will have to be burlapped. In anticipation of this, the undergrowth has been already removed from most of this infested woodland and the dead and dying trees have been cut. There is still an area of several hundred acres partly grown up to brush which should be cleared before spring opens. When this has been done, it will be necessary to keep down the undergrowth for two or three years, and each year to burlap and inspect thoroughly all these woods. To do this will require for the next three or four years nearly as large a force of men each year as was used there in 1898.

Everett.

Owing to the delay of the appropriation, it was impossible to inspect Everett thoroughly and destroy the eggs of the gypsy moth before they hatched, therefore the caterpillars were widely scattered through the city in 1898. The trees on every street were burlapped, and the number of egg-clusters in Everett at the present time is much less than the number left in the spring of 1898. When the burlaps were taken off, the trees were looked over and all the eggs seen were destroyed; but the whole city should have a thorough and careful inspection before the eggs hatch next spring. This will be possible if an early and adequate appropriation is made. The land in Everett being cleared and the trees being mainly shade and fruit, there should be no difficulty in exterminating the moths, provided the requisite means are promptly given to do all the work necessary each year in the city, as well as exterminate the moths from the adjoining cities of Malden and Medford.



Workers removing thick growth from infested sproutland, leaving trees for burlaps.

From a photograph taken in Medford, 1898.

Malden.

Malden is, with the exception of Medford, the most generally infested town in the gypsy moth region. Owing to the delay in making the appropriation for 1898, a large part of the worst-infested woodland could not be burned over. Where burning was done, very few caterpillars appeared, and most of those were taken under the burlaps; where the burning was not done, the caterpillars appeared in countless swarms. In one locality they stripped the foliage from the sprout land, and in migrating covered the sides of a house as high as the window frames. Here they were destroyed by the cyclone burner. They were so numerous in some localities on Baker's Hill that two or three burlaps had to be placed on each tree, and visits were frequently made to materially reduce their numbers.

The enormous increase of the gypsy moth in Malden this year gives fresh proof of its fecundity and destructiveness. It seems to spring up like a mushroom in the night, whenever the hand of its destroyer is stayed. It was found necessary to concentrate on this town a whole division of the force, and later another division was brought in to assist. Every man that could be spared from other work was set to killing caterpillars in Malden, and yet it was some time before the numbers of the pest began to be noticeably lessened. Fire was used on Baker's Hill in the fall, trees were trimmed up and all the undergrowth cut and burned. Every egg-cluster that could be found was destroyed. To-day three-fourths of Malden is in better condition than ever before, and the other fourth can be put in as good condition before spring, if the means are provided to continue the work.

Winchester.

On most of the infested estates in residential Winchester very few gypsy moths were taken in 1898. The caterpillars had been most numerous in the south-eastern corner of the town near the Middlesex Fells Reservation. A few Winchester colonies in the reservation appear to have been exterminated, and in nearly all the other colonies only a few caterpillars were found in 1898. In most of these colonies

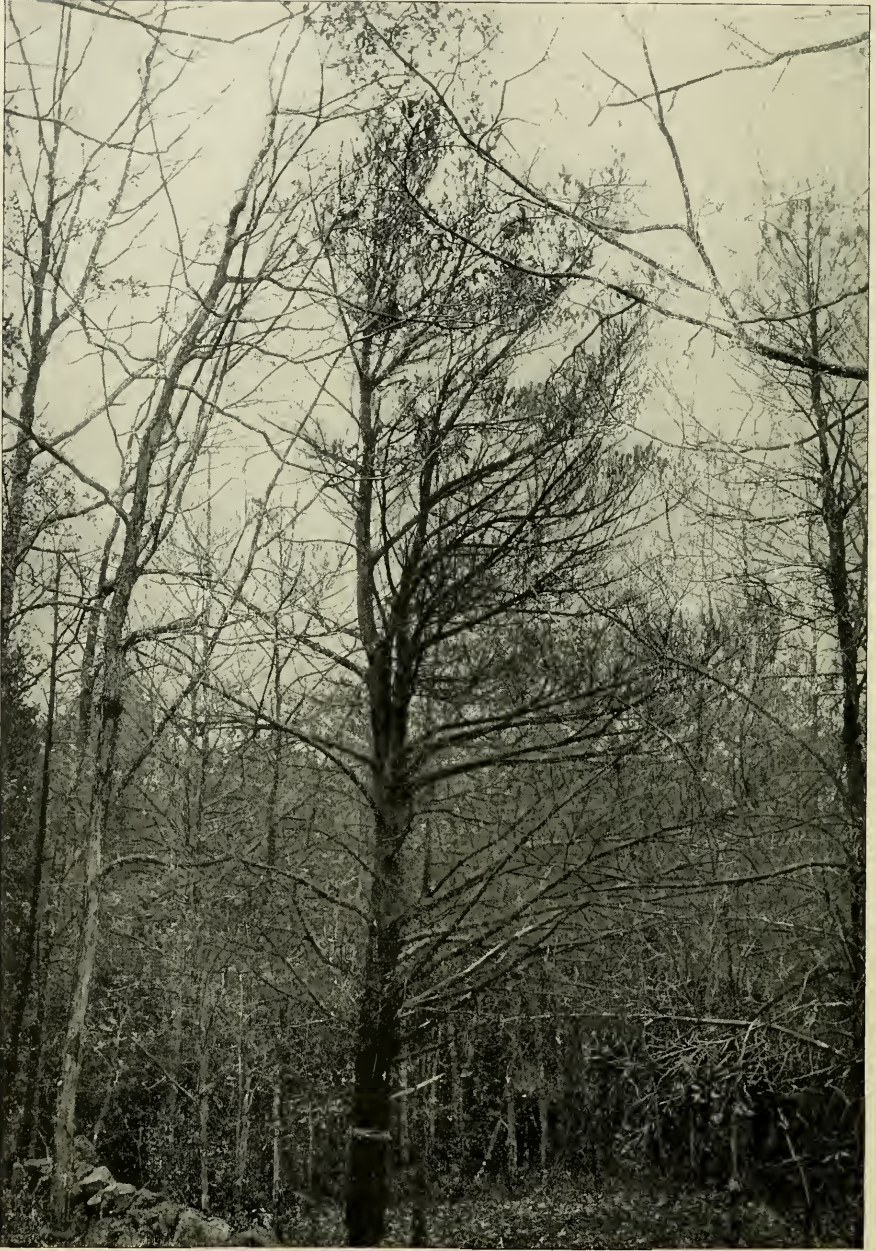
it will be necessary to cut out the underbrush to secure extermination. Where this has been done, the reduction in the number of caterpillars has been remarkable. In one colony there were taken in 1897 7,319 caterpillars, and in 1898 only 37. In another there were 669 caterpillars taken in 1897 and only 3 in 1898. Most of the colonies in the woods in the western part of Winchester which were formerly badly infested are to-day either exterminated or in good condition. Where the woods have been cut and the ground burned over, very few if any gypsy moths have been found thereafter. Where the woods have been thinned out and the underbrush cut and burned, the condition is now about the same as in those colonies where all the wood was cut off. In December a tract of woods which had been infested for several years, containing nearly 100 acres, was cut over, only a few trees being left to burlap. This greatly reduced the amount of work necessary for the extermination of the moth in this locality.

FOREST TREES KILLED BY THE GYPSY MOTH.

The fact that the gypsy moth destroys fruit and shade trees, many kinds of garden crops and forage plants, has long been accepted without question. But it has been regarded by many as hardly credible that it should destroy forest trees, in regions where vegetable food of many kinds is so plentiful and readily accessible as in our New England woods.

In my report of January, 1897, attention was called to the fact that pines had died of defoliation by the gypsy moth. It was also stated that some which had been quite severely attacked, although they had not been entirely stripped of their foliage, appeared to be dying. The observations of two years since that time have confirmed the belief that in all cases where coniferous trees are wholly or nearly stripped by the gypsy moth, they die. This moth attacks with avidity the pines, spruces and hemlocks. Where it is abundant and has its way it will strip the foliage from these trees, leaving the branches entirely bare. When this occurs, the trees generally die within a short time,

Plate VII.



Pine and oak woods attacked by the gypsy moth; the
trees are stripped and dying.

From a photograph taken in Lexington in July, 1895.

Plate VIII.



The same scene, showing the trees now dead from the effects of the stripping.

From a photograph taken in 1898.

although in some cases they make an attempt to re-foliate. Where the moth is not numerous enough to destroy the greater part of the foliage, or in cases where it has been checked by the men before it has finished its work, some of the trees revive, while others linger, perhaps, for a year, sicken and slowly die.

The scene in the Lexington woods, of which two views are given, one taken in 1895, the other in 1898, well illustrates a case of this kind (Plates VII, VIII). The photograph from which the first plate was made was taken in 1895, just after the caterpillars had been destroyed by the workmen of the gypsy moth force. The leaves were stripped from a considerable area here, and several pines were partially defoliated, one or two wholly so. The large, vigorous pine in the foreground, which, as may be seen, had not been wholly stripped when the men checked the progress of the moth, threw out some new foliage and appeared to revive for a short time, but before the end of the season it seemed to be dying, and in 1897 was undeniably dead. The picture taken in 1898 shows the remains of this pine, with other trees in the background, the pine dead and much eaten by wood-borers, the bark now falling off, and many of the oaks in the same condition.

In 1897 a number of large pines and hemlocks were killed by the gypsy moth in the Saugus woods, in the face of all that could be done by the agents of this Board to prevent it. They were situated in different localities, the pines being about a mile from the hemlocks. The hemlocks, some five or six large trees, were completely stripped, and never showed a sign of life afterwards. All but two of these trees were cut down. These two are yet standing. The pines, two very large trees at some little distance from each other, were nearly stripped. They failed immediately, and were evidently dead by the summer of 1898.

In 1896 there was a badly infested spot in the woods on Meeting-House Brook, adjoining and to some extent within the border of the Middlesex Fells reservation in Medford. The colony had spread into the reservation from the woods outside, where the ground was thoroughly burned over with oil in the spring to destroy any scattered moth-eggs. This

could not then be done in that part of the infested woodland included in the park ; but, in spite of all that was done by the force of men employed in this section, the moths attacked the pines in the reservation, and one of them was very nearly stripped. This large pine made heroic efforts to survive, but in the spring of 1898 it was dead. It is shown in the illustration (Plate IX). Had the ground under these trees been burned over early in the spring of 1896, there is no doubt that this pine might have been saved. Another large pine on Baker's Hill, Malden, where the ground was not burned over in the spring of 1898, was stripped by the gypsy moth and soon died and was cut down. The work of burning which has been done in the Middlesex Fells Reservation has prevented the destruction of many pines, both large and small.

The explanation of the death of these coniferous trees is simple. They do not so readily survive the shock of the destruction of their foliage as do the deciduous trees, and they are also particularly susceptible to the attacks of bark beetles when in the weakened condition superinduced by the loss of their foliage. Bark beetles attack them as soon as there is a dearth of sap, and they strike at the very life of the tree. Death before long ensues. If the defoliation of the woods continues for more than one year, other trees than the pines are destroyed. The woodlands in the infested region consist largely of pines and oaks, with some birch, maple, ash and other trees. The only wooded localities where defoliation was continuous for more than one season were grown up mostly to pines and several species of oak. Wherever defoliation has occurred for two successive seasons, even though lessened by the work of the agents of the Board, at least one-fourth of the oaks have died. This has been true even where the trees were young, sound and vigorous. In one infested locality in the Lynn Woods Reservation (which, owing to the pressure of work necessitated elsewhere, was not discovered until the trees on half an acre or more had been stripped), all the trees in or near the centre of this spot, where the attack was most prolonged and severe, have since died. There were several localities in the Saugus woods where, by total defoliation for one or two seasons, a

Plate IX.



**A large pine killed by the gypsy moth in the Middlesex
Fells Reservation.**

From a photograph taken in 1898.

large proportion of the oaks were killed. By reason of its long feeding season, the gypsy moth can keep the trees stripped from June to August, and it is this fact mainly which accounts for its destructiveness. As with the pines, so with the oaks. The defoliation is followed by the inroads of hordes of bark beetles, and these complete the destruction of the trees. Among the oaks the mortality is greatest in the case of the white oak, which is considered the most valuable tree of all. Nearly all the white oaks which are seriously attacked for two years in succession either die or become deformed by dying back from the ends of the branches and sending out shoots from the trunks. What the effect would be should the gypsy moth be allowed to increase in our forest reservations, may readily be conjectured.

The work of the Board has already saved thousands of fine and valuable trees in the reservations from absolute destruction.

THE PROGRESS OF EXTERMINATION.

In the outer three-fourths of the infested region the gypsy moths are now few and far between. The greatest progress of the year has been made in the Lincoln and Saugus woods.*

Since 1893 the Saugus woods have been until this year the worst-infested forested tract in the entire gypsy moth region. Another year of such work as has been done the past two years will class Saugus among the outer towns. The moths in the large colonies in the Middlesex Fells region have been reduced 99 per cent. For the first time in any year progress has been made in nearly all the infested region. Progress over the entire region would have been made had the \$10,000 deducted from the gypsy moth appropriation for preventing the spread of the brown-tail moth been available for use against the gypsy moth.

It must now be plain to all who have watched the progress of the work, that the plan pursued by the Board of Agriculture in the years previous to 1898 was the wisest that could be carried out with the limited appropriations granted.

* Much credit for the excellent work done here is due to Mr. C. E. Bailey, who has had charge of the work in Lincoln, and Mr. Geo. H. Harris, who has been in charge of all the work done in Saugus and the neighboring towns.

When appropriations are insufficient, something must always be left undone. The moths were attacked in all centres of population and in the badly infested woodland colonies farthest from the centre of the moth district, where they were then more numerous even than in the centre. They were thus prevented from further increase and from spreading into new territory (especially the woods) at a long distance from the centre, and were reduced to the point of extermination. Under this plan the increase of the moth has been allowed perforce in the centre only, where the creature can now be handled with much less expense and with much less danger of distribution outside of the infested district, in the mean time, than would have been the case had the plan followed been that of attacking the moths first in the central woodlands. If, following this latter plan, the main part of the exterminative work had been directed first against the moths in the centre, while they were left to increase almost unrestricted in the outer towns, this increase would now be beyond control.

The reduction of further appropriations can have only one result—it will perpetuate the work. An attempt to exterminate the gypsy moth with insufficient means will fail even to prevent its spreading. The only way to prevent the gypsy moth from spreading is to exterminate it. Unless appropriations can be made large enough to continue a supreme effort to exterminate the moth, the work had better be abandoned. The gypsy moth can never be exterminated from this Commonwealth until steady progress is made in each infested town each year until the end. No progress over the entire region is possible for the present with an appropriation of less than \$200,000.

Respectfully submitted,

E. H. FORBUSH.

APPENDIX.

IMPROVEMENTS IN SPRAYING MACHINERY.

BY E. H. FORBUSH.

The experiments of 1891 and 1892 in spraying for the gypsy moth on a large scale showed that there were several requisites needed to make such spraying more effectual. It was evident that machinery must be devised that could be used with ordinary care without breaking down. With the bringing out of arsenate of lead as an insecticide, other problems came up to be solved. The determination of the essential needs was a question of very short time, but to supply these needs required a great deal of experiment, observation and invention.

For spraying trees and shrubbery in a wholesale manner a simply constructed pump is needed, made without packing; one that will not get out of order or admit of the clogging of its valves, and that will give a steady, continuous pressure sufficient to run several nozzles, but not sufficient to burst the hose when the spray is shut off. The pump must be provided with an agitator that can be kept constantly in motion by the pumping mechanism. The hose must be as small in size as can be used, and must be light, strong and durable. It must be coupled with a coupling that will not reduce its inner diameter, and that cannot be broken or torn apart by any strain that may be brought to bear upon the hose in ordinary spraying. The spraying pole must be light, long and strong, with a good automatic shut-off. The nozzles must be simple in construction, so that they cannot clog or get out of order, and the parts interchangeable and so constructed as to give a good volume of very fine spray.

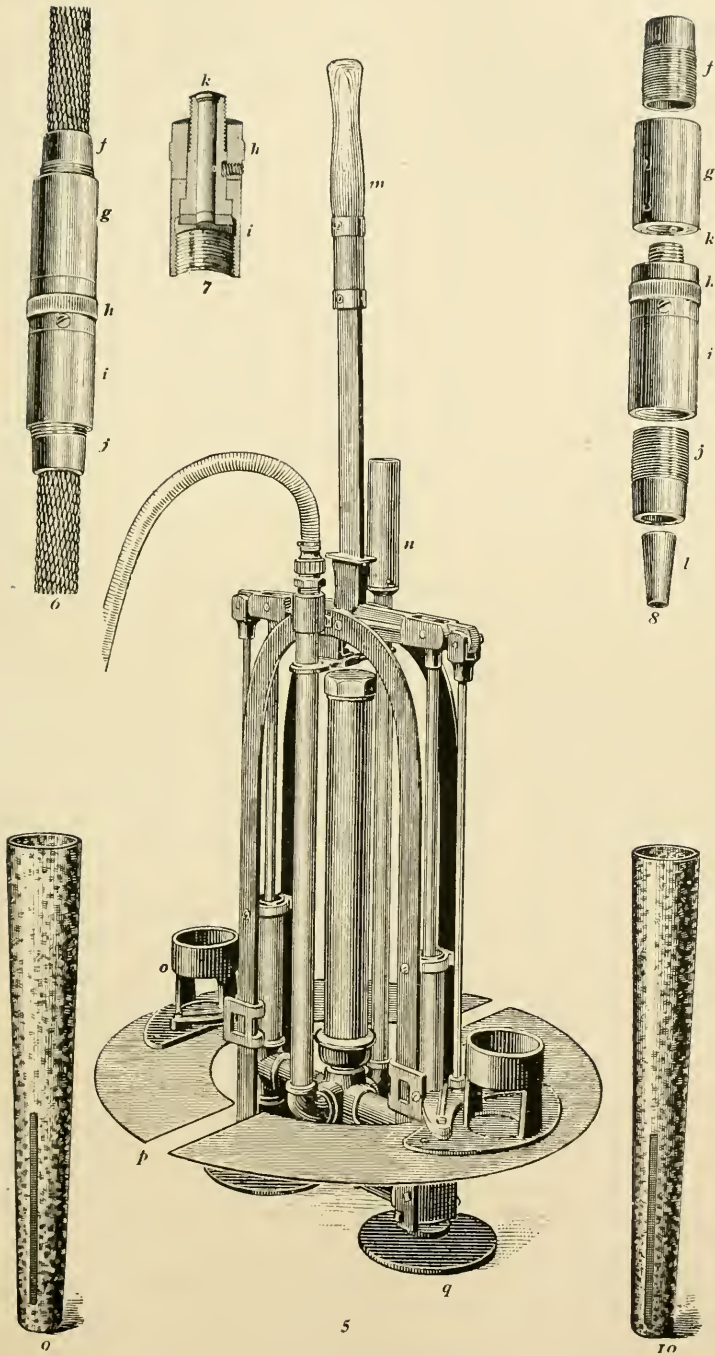
In 1896, arsenate of lead having been proved an effective insecticide for use on the gypsy moth, my assistant, Mr. E. C. Ware, was directed to make experiments with a view to perfecting such spraying machinery as was then in use, and improving any parts which were not then satisfactory. Mr. Ware accordingly

built a small machine shop, and, with the assistance of Mr. John Hancock, a skilled machinist, the invention and manufacture of nozzles, hose, couplings, poles, pumps, tanks and trucks, for use in the field work of the Board, was begun. Several different machines were made and used in the field, but the one which is herein described has given the best service, and is considered a distinct improvement over anything yet made for the purpose. Much time and thought have been given to the study of steam or gasoline engines for spraying; but the use of these engines was finally abandoned, as the pump alone is less complicated, and consequently less likely to break down and thereby cause delay in the field.

THE PUMP.

The pump (shown on Plate X, Fig. 5) is built somewhat on the principle of that used in the hand fire engine, but is worked by one man, with a detachable lever (*m*) in place of the brake. All the working parts are made of brass or composition, to resist the corrosive action of the arsenate of lead. The volume of water thrown is small, but with a small outlay of power a pressure of eighty to one hundred pounds to the square inch can be had, this being all that is ordinarily required to get the best results in spraying. The pump is placed inside the tank, and when the tank is full is under water; the machine is thus compact, and a number of connections and devices, usually required where the pump is outside the tank, are done away with. The pump is so constructed that no stuffing boxes are necessary; this does away with all packing, and saves the time so often lost in repacking. There is an agitator attachment, consisting of two sheet-iron plates (Plate X, Fig. 5*p*). These are fastened to the cross-beam, and by it are worked alternately up and down through the liquid so long as pumping is continued. This keeps the liquid agitated, and for this purpose the pump should be kept working continually. When the pressure reaches eighty to one hundred pounds, the relief valve (*n*) comes into play, and the water which is released from the valve flows back into the tank. If spraying is not in progress and the water is shut off from the nozzles, the relief valve, by preventing a higher pressure, saves the hose. From one to three nozzles, containing four outlets each, can be run at this pressure by one of these pumps. To prevent a clogging of the machine by foreign material, the holes which are drilled in the suction pipe are covered with a fine brass wire screen, the meshes of which are finer than the outlet of the nozzle. On the upper surface of each of the agitators there is fixed a cylindrical iron

Plate X.



Spraying pump and hose coupling.

socket (*o*), into which the long, cup-shaped receptacles (Plate X, Figs. 9 and 10) are inserted. These are designed one to contain arsenate of soda and the other acetate of lead. The slits on either side of these mixers are covered with a fine brass wire screen, and, as the mixers move up and down with the agitators, the chemicals are dissolved and work out through the wire screens into the liquid. The pump can be used in any tank or barrel, for it can be attached to the bottom of the tank by iron buttons, which are not shown in the cut.

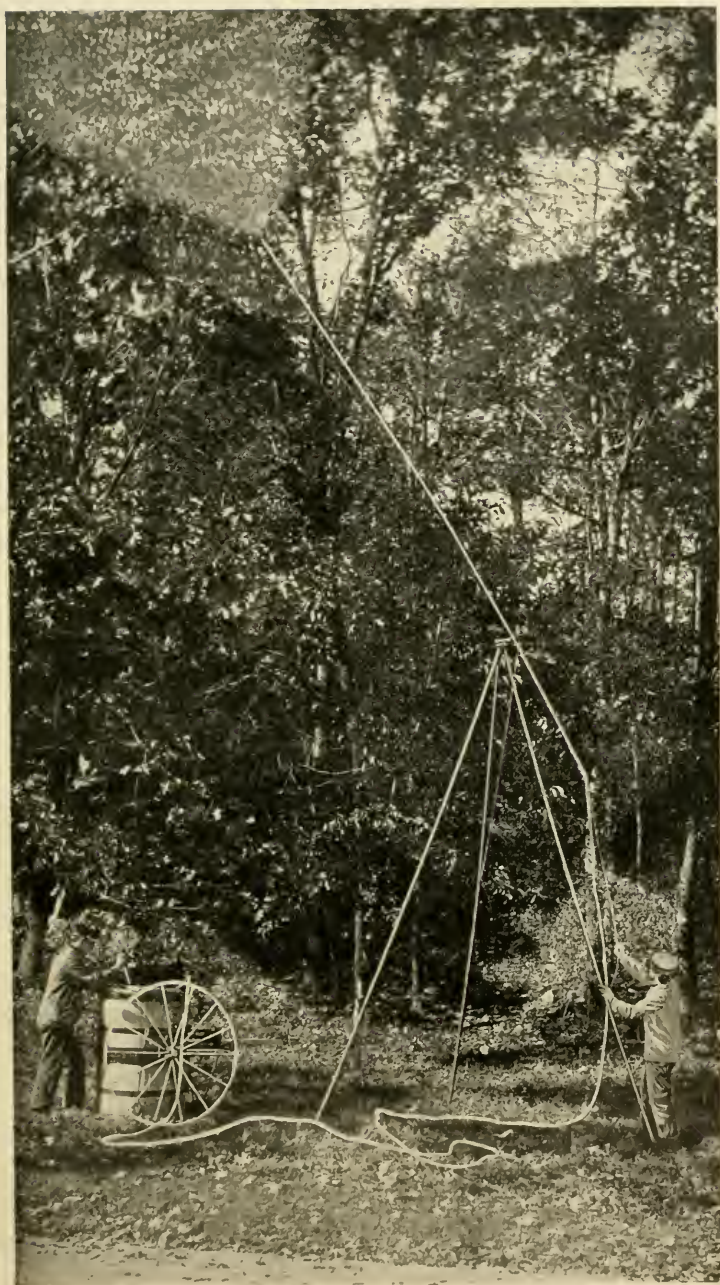
HOSE AND COUPLINGS.

The hose now in use is the smallest and lightest that has ever been made for spraying. Soon after work on the gypsy moth was begun, in 1891, Prof. C. V. Riley recommended the use of quarter-inch hose, but none could then be obtained. Rubber tubing had not sufficient strength. The hose now used is one-fourth-inch woven cotton hose, lined with rubber and made especially for this work. Although small and light, it is strong and durable and answers every purpose. Before the hose could be used in the field it was necessary to invent a coupling which would not reduce the size of the aperture. The coupling invented for this purpose is illustrated on Plate X, Figs. 6, 7 and 8. Fig. 6 shows the coupling attached to the hose and screwed together. The parts are lettered to correspond with those shown in Figs. 7 and 8. The manner in which the hose is inserted into the coupling may be readily understood by a glance at Fig. 8. The piece *j* is slipped on the outside of the hose and pushed back an inch from the end; the piece *l*, which is a tapering-cylinder with a quarter-inch hole, is then put into the end of the hose and driven down; the piece *f* is passed over the opposite end of the hose, which is to be coupled, and a piece similar to *l* is driven in there. The two pieces *f* and *j* are then drawn forward, as far as possible toward the ends of the hose, and the threads in pieces *g* and *i* are connected with the threads of *f* and *j* and screwed down tightly. Fig. 7 shows the construction of a swivel joint, which connects the hose tightly together without the necessity of turning either piece of hose in coupling. This does away with the use of the washer or gasket which is used with the ordinary coupling, and which is often lost, causing a leakage. The pieces *h* and *k*, fastened together as they are by the screw, form a movable piece, which can be turned to the right or left, the thread in *k* entering the thread in *g*, drawing the coupling and hose together, as shown in Fig. 6.

EXTENSION POLES.

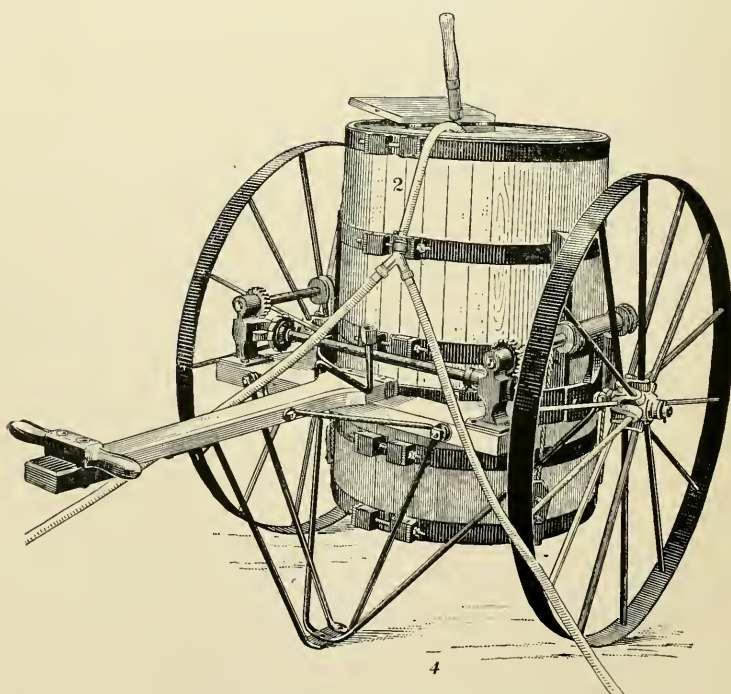
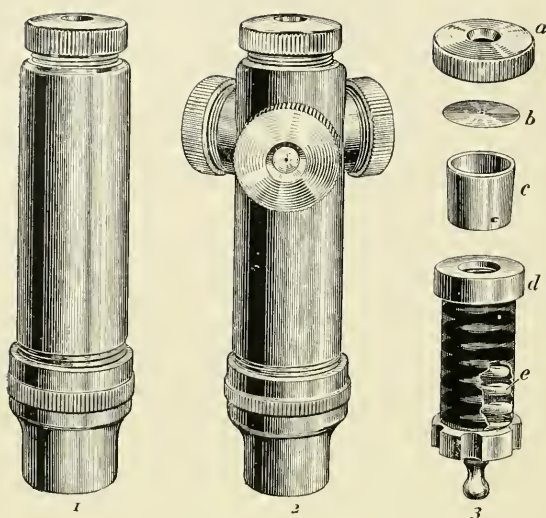
In spraying trees from the ground, no nozzle which will throw a spray sufficiently fine to poison thoroughly the foliage can be depended upon to throw the spray to any distance, therefore some apparatus to raise the nozzle into the air is a necessity. Some experiments have been made with machines for the purpose of raising a nozzle from forty to seventy feet. While it is not difficult to perfect a machine which will do this on level ground, it seems impracticable to use any machine of this kind on the rough and rocky hillsides in the woods of eastern Massachusetts. The only machine of this sort which has been tested in the field on the gypsy moth work is illustrated on Plate XI. This consists of two telescoping brass tubes, each about twelve feet in length, mounted on a tripod consisting of three wooden poles, the lower ends of which are weighted by heavy iron piping. At the upper end of the smaller and inner tube there is placed a nozzle with several outlets; at the lower end of the larger tube the spraying hose is attached. This machine can be folded together and readily carried by one man. It can be quickly set up, and when necessary the inner tube can be telescoped out to nearly its full length by means of a cord and pulley. By holding the hose, the sprayer can then direct the nozzle at will. While this machine has demonstrated the possibility of spraying high trees in this manner, it has never come into general use on the gypsy moth work, mainly because of its liability to injury by careless handling. It is given here merely to show the possibilities in this direction. The extension most used is a single pole twelve or fourteen feet in length. This pole consists of a five-sixteenth-inch brass tube, to which the hose is coupled at the lower end and the nozzle at the upper. This tube is strengthened by being enclosed in a tube made of white spruce wood one and one-quarter inch in diameter, the pole being bound together by ferrules made by winding brass wire closely about it and running in solder until the whole ferrule is solid. This pole is provided with a hook at the top, so that in moving about in a tree the hose and extension can be hooked onto a branch or ladder. It is also provided with two clamps, which hold a rod which projects fifteen inches beyond the lower end. This is done to prevent wear and tear of the hose, which otherwise would soon be worn out and broken off by contact with the ground. An automatic shut-off enables the sprayer to control the flow of the liquid.

Plate XI.



Spraying with the telescoping extension pole.

Plate XII.



Spraying nozzles, tank and truck.

NOZZLES.

The nozzles principally used are shown on Plate XII, Figs. 1, 2 and 3. Fig. 1, the cyclone nozzle, is principally used in spraying oil with the cyclone burner. This nozzle gives a perfect spray, and is sufficient in itself where a small amount of spraying is to be done. Much more work, however, can be accomplished in the same time with No. 2, the "Monitor" nozzle, which has four outlets. This nozzle consists of a straight cylinder about three inches long, with a reducing fitting on the lower end, while the opposite end has, in addition to the regular outlet, three side outlets of the same size. Into each of these four outlets is inserted a cup (Fig. 3*c*), pierced with two small holes opposite each other. The water entering here is given a rotary motion, like that of the original Riley or the Vermorel nozzle. On top of each of these cups is placed a small disc (Fig. 3*b*) of hardened brass, seven one-thousandths of an inch in thickness. Through the centre of each a small hole is drilled to make an outlet for the water. This disc, being first placed on the cup, is held in position by screwing down the cap (*a*). The fineness of the spray can be regulated by the size of the hole drilled in the disc. Although the suction pipe of the pump is covered with a fine screen, there is still danger of clogging at the nozzle, when glucose or other adhesive materials are used in the mixture. To prevent this, the part (*d*), which is merely a cylindrical strainer, is inserted at the lower end of the nozzle. This strainer is made of brass wire cloth, and is kept distended by a brass spiral spring (*e*). It fits tightly into the cylinder of the nozzle, and all the fluid must pass through it. If this screen should become clogged, the nozzle must be taken from the pole and the strainer removed by means of the little handle at the lower end, quickly washed and replaced.

THE TANK AND TRUCK.

The tank and truck are shown on Plate XII, Fig. 4. Experiments having been made with all sorts of tanks, it was decided that wood is the most durable material. The tanks now in use are constructed of one-inch cypress, and have a capacity of one hundred gallons each. The staves being grooved on both edges with a half-round groove, a five-sixteenth-inch, hard-wood dowel is inserted to hold them in position. They are so grooved that room is allowed for shrinking and swelling of the staves and dowels. To guard against shrinkage, the hoops are so arranged that the staves can be drawn together by means of a bolt. Both these devices

are shown in Fig. 1. The tank is thus made tight, and with due care will last for years. It is provided with a cover which fits into the top, and in this cover another smaller cover works on hinges, giving room for the insertion of both hose and pump lever. The tank may be placed on the ground or used in a wagon or cart, but a truck made especially for spraying trees has been designed for its reception. The truck, which is shown with the tank on Plate XII, Fig. 4, consists of two iron wheels

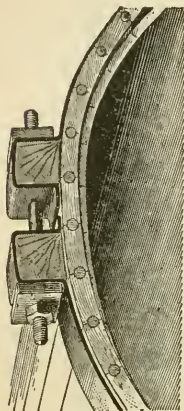


FIG. 1.

with wide tires, supporting upon their axles a heavy iron ring, through which the tank is raised or lowered. The tank is hung within the ring on four iron grapples, which hook on to its lower edge. To each of these grapples is attached a wire cable. These cables are attached to drums revolving on iron shafts,

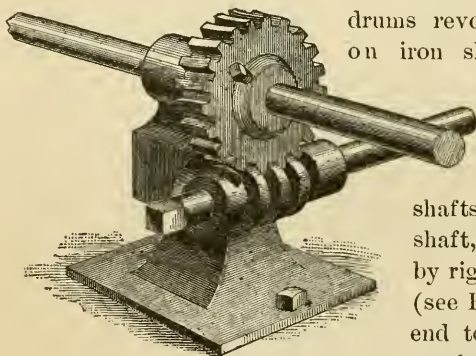


FIG. 2.

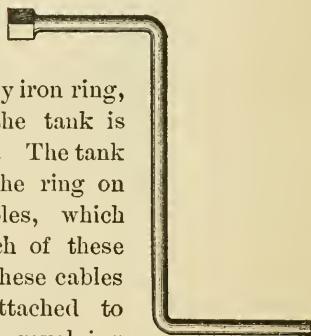


FIG. 3.

which are supported above the axles on either side of the tank. Both these shafts are turned by another shaft, which is geared to them by right and left worm gears (see Fig. 2) and has a square end to which the socket of a crank can be applied. (See Fig. 3.) By means of this

device the tank can be raised sufficiently to clear ordinary obstacles, and is held by a ratchet while being moved from place to place. It can be lowered sufficiently to rest on the ground when in use.

AN EGG-EATING BEETLE.

A. F. BURGESS, M.S.

Broken egg-clusters of the gypsy moth are of somewhat frequent occurrence in the infested region, and the scattered eggs that fall from them delay and complicate the task of exterminating the moth. The egg-clusters are broken by birds, squirrels, ice, rain, and sometimes, as in the case to be described, by insects. The damage from this latter cause may be compensated by the destruction of eggs.

On Oct. 9, 1897, several of these infested egg-clusters were found at Malden. They had been deposited on the woodwork of a building, just above the brick foundation. Some were apparently intact, with the exception of a small hole in the surface; while in other cases little remained except the hairy covering of the nest, compacted in small masses. On close examination larvæ was found within some of the nests. The infested clusters were collected and taken to the insectary for study. After keeping these egg-clusters for a short time, it was found that the larvæ were feeding on the eggs, as shown by the empty shells remaining in the jars where the insects were confined. A small part of the hairy covering also was consumed. The larvæ under observation at the insectary continued to feed until the room in which they were kept was closed for the winter. They hibernated successfully, and in April, after the room had been heated for a few weeks, changed to pupæ, from which two adults of *Anthrenus verbasci* Linn. emerged May 3, and others followed at intervals of a few days.

During the larval stage about one-third of the eggs and one-half of the hair contained in the clusters supplied were consumed. Although the larvæ feed chiefly beneath the surface of the egg-masses, some of the eggs are loosened to such a degree that they might be scattered easily by rain or wind.

This insect has gained much notoriety as a museum pest; but

it is evident that its carnivorous habits sometimes lead it into rendering at least slight services to mankind. Dr. L. O. Howard* found it in 1896 feeding on the eggs of the tussock moth (*Orgyia leucostigma*), the insect that in the previous year defoliated the elms on Boston Common, and committed other serious depredations throughout eastern Massachusetts. In Europe a few Dermestid beetles have been found feeding on the eggs of the gypsy moth, but no member of this family having this habit has been recorded heretofore in this country.

Descriptions of the larva and pupa of this interesting beetle are given below:—

Full-grown Larva.—Length, 4.2 mm. Width at prothorax, 1 mm.; at fifth abdominal segment, 1.2 mm. Body somewhat cylindrical in form. Head narrower than prothorax. Abdominal segments beyond the fifth tapering slightly to the end of the body. Color, seal-brown above; posterior margin of each segment with a broad band of yellowish white. Dorsal line impressed. Head small, partly depressed beneath the prothorax, and bearing spines. Prothorax nearly as long as the meso- and meta-thorax together; slightly wider behind than in front. Dorsum with a transverse row of long spines near the anterior margin, the remainder of the segment sparsely spiny. Hind angles rounded. Front margin broadly yellowish white, hind margin with a narrow band of the same color. Meso- and meta-thorax about equal in width and length, each segment truncate behind, the posterior angles being nearly rectangular. Transverse row of spines on each of these segments arranged near the middle of the dorsum. Abdominal segments one to five subequal, and each bearing a dorsal row of spines placed similarly to those on the meta-thorax. Each has a transverse ridge near the anterior margin, while the posterior yellowish-white band is more than half the width of some of the segments.

Beyond the fifth segment on each side of the dorsum arise numerous long, fine, grayish-colored hairs, which form a dense brush, nearly meeting above and obscuring the rest of the body. Sides of all the segments provided with a cluster of spines; venter having a transverse row and numerous scattered spines on each segment. Legs short; four easily recognizable joints. Femur stout; outer edge bearing long spines, which under low magnification appear segmented, but when highly magnified are thickly set with short barbs. Tibia slightly longer than femur; spines short and simple. Tarsus one-jointed, tapering to the one-jointed ap-

* Bull. 5, Tech. Ser. Div. Ent., U. S. Dep. Agr., page 46.

pendiculate claw, which has a single opposing spine near the base. Tarsal spines short, simple. The clusters of spines on the sides of the abdomen when highly magnified are similar in structure to those on the femur.

When the time for pupation arrives, the larva shortens and thickens (one specimen measured 3.8 mm. in length and 2 mm. in width). The integument is then ruptured along the dorsal line of the whole body, the pupa remaining within the exuviae until ready to emerge. A pupa removed from one of these cases soon after pupating was pale yellow in color, broadly oval in form, and measured 3.2 mm. long and 1.6 mm. wide.

ON THE VALUE OF GLUCOSE IN SPRAYING.

A. H. KIRKLAND, M.S.

In the spraying operations against the gypsy moth, limited as they are to a season of about four weeks, and usually hampered by frequent rains, our aim has been to apply the insecticide, arsenate of lead, in as great a strength as is consistent with economy. Producing the poison, as we do, at a cost not exceeding 7 cents per pound for the mixture, and with perfected spraying apparatus whereby nearly all wasting of the spray has been eliminated, it has been found practical to apply the insecticide at the rate of 25 pounds of the mixture (or $12\frac{1}{2}$ pounds actual arsenate of lead) to 150 gallons of water, and in field work this proportion has yielded excellent results. The custom of adding glucose to the spraying mixture at the rate of 4 to 6 quarts to 150 gallons has been followed from the earliest days of the work, it being considered that this substance was of value in retaining the poison upon the foliage. The cost of glucose has been a considerable item, the labor of dissolving it a greater one; and, since the benefit derived from its use has been repeatedly questioned, the matter was made a subject for investigation during the past summer.

The opinion has been held that the addition of glucose to the spraying mixture increased the amount of poison adhering to the foliage, thus making the insecticide more effective. This being the generally accepted assumption, it seemed that the fact could be tested in at least three different ways.

1. TESTS BY INSPECTION.

On June 14, 1898, five areas of oak brush were sprayed with arsenate of lead, at the rate of $12\frac{1}{2}$ pounds to 150 gallons of water, one area being sprayed without the use of glucose, the remaining four being treated with various amounts of glucose mixed with the spraying solution. The exact treatment was as follows:—

- No. 1, no glucose.
- No. 2, 4 quarts glucose to 100 gallons of water.
- No. 3, 6 quarts glucose to 100 gallons of water.
- No. 4, 8 quarts glucose to 100 gallons of water.
- No. 5, 10 quarts glucose to 100 gallons of water.

The sprayed bushes were suitably tagged (not in the order given above), and, after passing through several showers, were examined on June 23 at my request by Mr. Forbush and Professor Fernald, who were unable to decide, so far as the apparent amount of poison was concerned, which area was sprayed without glucose and which ones were treated with glucose solutions. Other examinations by some of our most experienced employees at later intervals gave the same result. This method of investigation, however, is an indirect one, since all that is obtained is a consensus of opinion. Greater weight may be attached to the results of the tests to be detailed.

2. CHEMICAL TESTS.

On August 4, fifty-one days after the time of spraying, fair samples of foliage, eight leaves each, were gathered from the bushes sprayed without glucose and from those sprayed with glucose at the rate of 4 quarts to 100 gallons of water. These samples were submitted to our chemist, Mr. F. J. Smith, who examined equal weights of the ground foliage for arsenic. From the sample where no glucose was used, 2 grams of pulverized foliage yielded 5.3 mgms. of arsenate of lead. The sample of foliage treated with glucose yielded .72 mgm. arsenate of lead from 2 gms. foliage. In other words, the glucose-treated foliage retained less arsenic than that sprayed with a normal mixture. The unexpected wide difference in the results of these two analyses led Mr. Smith to analyze later in the season (September 1) two entire bushes from the experimental plots. One of these bushes had been sprayed without the use of glucose, the other with glucose at the rate of 6 quarts to 100 gallons of water. The results of these later analyses are much more satisfactory, because of the increased amount of material used. From Mr. Smith's report I take as follows:—

Analyses of foliage sprayed with arsenate of lead; leaves dried at 100° C.:—

No. 1, no glucose: 31.5 grms. leaves give 41.5 mgs. arsenate of lead ($\text{Pb}_3(\text{AsO}_4)_2$, or 9.17 gr. per pound.

No. 2, with glucose: 31.05 grms. leaves give 52.3 mgs. arsenate of lead ($\text{Pb}_3(\text{AsO}_4)_2$, or 11.76 gr. per pound.

The difference of 2.59 gr. per pound is infinitesimal.

This shows a difference which the chemist properly characterizes as "infinitesimal" in favor of the glucose-treated foliage. It is also of interest to note that, although careful tests of the foliage of the bushes treated with glucose solutions were made by Mr. Smith for several days subsequent to spraying, no glucose could be found on the leaves after the first shower.

3. THE PHYSIOLOGICAL TEST.

The test of feeding the poisoned leaves to caterpillars gives, of course, the most reliable results. For this purpose the foliage was allowed to "weather" for eight days, when duplicate lots of ten gypsy moth caterpillars each were fed upon the differently treated leaves until all the insects were dead. The larvæ were confined in breeding jars, and the foliage was gathered fresh daily.

The average results of the duplicate experiments were as follows:—

No. 1, no glucose: all larvæ dead in $17\frac{1}{2}$ days.

No. 2, 4 quarts glucose to 100 gallons water; larvæ dead in $14\frac{1}{2}$ days.

No. 3, 6 quarts glucose to 100 gallons water; larvæ dead in $19\frac{1}{2}$ days.

No. 4, 8 quarts glucose to 100 gallons water; larvæ dead in 16 days.

No. 5, 10 quarts glucose to 100 gallons water; larvæ dead in 16 days.

The extreme range in the time at which these experiments terminated is five days, the test with normally sprayed foliage exceeding slightly the average period.

On August 5, fifty-two days from the time of spraying, there was commenced an experiment in feeding this poisoned foliage to larvæ of the fall web worm as a check with another insect upon the preceding work. No duplicate experiments were run. The results follow:—

No. 1, no glucose: all larvæ dead in 10 days.

No. 2, 4 quarts glucose to 100 gallons of water: all larvæ dead in 10 days.

No. 3, 6 quarts glucose to 100 gallons of water: all larvæ dead in 12 days.

No. 4, 8 quarts glucose to 100 gallons of water: all larvæ dead in 9 days.

No. 5, 10 quarts glucose to 100 gallons of water: all larvæ dead in 12 days.

The results show a range of three days in the dates of closing the tests, the one where normally sprayed foliage was used falling a little inside the average duration of the experiments.

The indoor experiments were roughly checked by field tests, where areas of badly infested brushland were sprayed with the same proportions of arsenate of lead and glucose as in the experiments described. In these cases the killing of the larvæ was apparently uniform, no difference being noted between the plot where glucose was not used and those sprayed with glucose solutions. This result has been checked by an examination of the locality for egg-clusters.

In the use of arsenate of lead, as at present prepared, we are dealing with an original precipitate, matter in its finest state of division. The case may be compared to that of the use of Bordeaux mixture, where the sulphate of lime, noted for its adherence to foliage, is a fresh precipitate. Such a flocculent precipitate as arsenate of lead finds ready lodgement on the irregularities of the foliage, even attaching itself to the leaf-hairs, and after a few hours dries down to a varnish-like film, which adheres until the leaves drop. I do not recall any other insecticide that would destroy leaf-eating insects fifty-two days after the time of spraying.

To summarize: from the various tests described, we are unable to attribute any especial value to glucose as an ingredient of spraying mixtures containing freshly prepared arsenate of lead. The fact that the glucose disappears from the foliage after the first shower shows that its effect, if there is any, is transitory. The final determination of the matter can best be reached by the extensive spraying operations of a season; but, from the results above recorded, it would seem to be more economical to abandon the use of glucose.

ANNUAL REPORT

OF THE

BOARD OF CATTLE COMMISSIONERS,

IN ACCORDANCE WITH SECTION 51 OF CHAPTER 491
OF THE ACTS OF 1894.

JANUARY 11, 1899.

REPORT OF THE BOARD OF CATTLE COMMISSIONERS.

To the Honorable Senate and House of Representatives.

The Board of Cattle Commissioners do hereby present their annual report of the work done by them during the year 1898, as provided for in section 51 of chapter 491 of the Acts of the year 1894.

At the beginning of the year 1898 the Legislature appropriated \$20,000 for the temporary carrying on of the work until a further appropriation could be made, and from that time until the beginning of April the work was continued on the same basis as in 1897, viz. :—

First. — The supervision and direction of the work of the local inspectors appointed by the cities and towns under the provisions of chapter 491 of the Acts of 1894, and the examination of all animals quarantined by them as suspected of being afflicted with a contagious disease.

Second. — The examination of cattle coming into the markets at Brighton, Watertown and Somerville from without the State for sale, and the examination and identification of cattle coming from without the State upon special permit.

As heretofore, under section 1 of chapter 491 of the Acts of 1894, the mayor and aldermen of cities and the selectmen of towns must appoint one or more persons to be inspectors of animals and provisions. These inspectors must make regular and thorough inspections of all neat cattle, sheep and swine found within the limits of their several towns, when ordered to do so by the Board of Cattle Commissioners. Under the law they must also make inspections of any domestic animal, whenever they have knowledge or reason to believe that such animal is affected with any contagious disease; and they shall also examine at the time of slaughter all neat cattle, sheep and swine

slaughtered at slaughter houses licensed under the provision of this law.

During the past year 457 inspectors have been appointed by the various cities and towns, and from January 1 until the middle of April 592 animals have been placed in quarantine by them, under suspicion of having tuberculosis.

The following table shows the number of animals condemned, killed and paid for during January, February, March and a portion of April:—

CITY OR TOWN.	Number Paid for.	Amount Paid.
Abington, ...	1	\$35 00
Acton, ...	2	30 00
Agawam, ...	1	25 00
Amesbury, ...	2	65 00
Amherst, ...	2	40 00
Andover, ...	4	140 00
Ashby, ...	3	82 00
Athol, ...	2	50 00
Barnstable, ...	1	20 00
Barre, ...	4	76 00
Bedford, ...	2	30 00
Belchertown, ...	6	150 00
Bellingham, ...	1	5 00
Berlin, ...	1	37 50
Beverly, ...	2	30 00
Billerica, ...	7	223 00
Blackstone, ...	1	35 00
Bolton, ...	4	121 00
Boston, ...	6	227 50
Boxborough, ...	4	130 00
Boxford, ...	9	295 00
Brimfield, ...	2	40 00
Brockton, ...	2	57 50
Brookline, ...	2	70 00
Canton, ...	1	23 00
Carlisle, ...	3	90 00
Charlton, ...	7	157 00
Chelmsford, ...	16	468 00
Chicopee, ...	1	30 00
Concord, ...	9	233 00
Conway, ...	9	195 50
Danvers, ...	2	52 50
Dedham, ...	9	262 50
Deerfield, ...	3	55 00
Dighton, ...	1	20 00
Dover, ...	3	110 00
Dracut, ...	1	28 00
Dunstable, ...	1	7 00
East Bridgewater, ...	3	95 00
Easton, ...	4	155 00

CITY OR TOWN.	Number Paid for.	Amount Paid.
Enfield, ...	1	\$15 00
Foxborough, ...	1	30 00
Framingham, ...	1	45 00
Franklin, ...	6	150 00
Freetown, ...	1	12 50
Gardner, ...	5	177 00
Gill, ...	8	207 00
Grafton, ...	4	95 00
Granby, ...	8	238 00
Greenfield, ...	5	138 60
Greenwich, ...	1	20 00
Groton, ...	1	47 50
Hadley, ...	2	60 00
Hamilton, ...	1	35 00
Hardwick, ...	8	175 00
Harvard, ...	14	452 02
Hatfield, ...	1	37 50
Haverhill, ...	4	115 50
Hinsdale, ...	1	15 00
Hopkinton, ...	5	138 00
Hudson, ...	1	15 00
Hyde Park, ...	1	50 00
Ipswich, ...	2	55 00
Lancaster, ...	6	165 50
Lawrence, ...	3	113 00
Lenox, ...	7	225 00
Leominster, ...	2	33 00
Leyden, ...	2	49 00
Lincoln, ...	3	47 50
Littleton, ...	8	236 00
Longmeadow, ...	1	30 00
Ludlow, ...	2	55 00
Lunenburg, ...	10	286 50
Lynn, ...	3	88 00
Mansfield, ...	1	12 00
Mattapoisett, ...	1	15 00
Maynard, ...	3	102 50
Medfield, ...	1	27 50
Mendon, ...	3	72 50
Millbury, ...	2	40 00
Millis, ...	2	60 00
Milton, ...	2	37 50
Monson, ...	3	74 50
Natick, ...	1	27 50
New Bedford, ...	4	170 00
New Braintree, ...	1	20 00
Newton, ...	1	10 00
Norfolk, ...	2	35 00
North Andover, ...	8	204 50
North Attleborough, ...	2	35 00
North Brookfield, ...	1	22 50
North Reading, ...	5	130 00
Northampton, ...	8	222 50
Northborough, ...	1	20 00
Norwell, ...	1	25 00

CITY OR TOWN.	Number Paid for.	Amount Paid.
Norwood, ...	1	\$12 50
Oakham, ...	3	115 00
Orange, ...	3	92 00
Palmer, ...	1	20 00
Paxton, ...	1	18 00
Peabody, ...	1	18 00
Pepperell, ...	2	62 00
Petersham, ...	1	19 00
Phillipston, ...	2	17 50
Prescott, ...	3	52 50
Princeton, ...	4	85 00
Randolph, ...	2	47 50
Reading, ...	5	130 00
Rehoboth, ...	4	55 00
Rockland, ...	3	95 00
Rowley, ...	1	12 00
Royalston, ...	3	75 00
Rutland, ...	5	110 50
Salem, ...	1	13 00
Salisbury, ...	2	53 00
Sandisfield, ...	2	77 00
Saugus, ...	1	25 00
Sharon, ...	1	40 00
Shelburne, ...	2	60 00
Sherborn, ...	3	75 00
Shirley, ...	2	34 00
Shrewsbury, ...	1	17 00
Southborough, ...	1	32 00
Spencer, ...	1	27 00
Springfield, ...	2	40 00
Sterling, ...	11	325 50
Sturbridge, ...	2	33 00
Sudbury, ...	1	45 00
Sutton, ...	2	50 00
Templeton, ...	1	40 00
Tewksbury, ...	4	87 00
Townsend, ...	2	50 00
Tyngsborough, ...	2	50 00
Uxbridge, ...	2	47 00
Walpole, ...	1	37 50
Waltham, ...	4	103 00
Ware, ...	5	149 50
Warren, ...	3	61 50
Warwick, ...	1	25 00
Watertown, ...	4	122 00
Wayland, ...	2	30 00
West Bridgewater, ...	13	490 00
West Brookfield, ...	2	55 00
West Newbury (balance on claim), ...	-	1 00
West Springfield, ...	1	40 00
West Stockbridge, ...	1	30 00
Westborough, ...	10	292 50
Westford, ...	8	198 00
Westhampton, ...	1	20 00
Westminster, ...	8	165 00

CITY OR TOWN.	Number Paid for.	Amount Paid.
Weston, ...	3	\$55 00
Westport, ...	3	80 50
Whately, ...	5	151 50
Wilbraham, ...	1	7 50
Williamsburg, ...	1	22 50
Wilmington, ...	3	108 50
Woburn, ...	2	35 00
Worcester, ...	13	304 00
Worthington, ...	6	172 50
Totals, ...	518	\$14,025 62

The above table includes the amount paid this year for 227 animals which were condemned and killed last year, the warrants for which were in process of settlement at date of last report. This table, however, does not include 6 animals which have been condemned this year, for which claims have not been approved.

The financial statement is as follows :—

Paid for cattle condemned, killed and found tuberculous,		
506 head, average price \$27.13, ...		\$13,732 12
for cattle condemned, killed and no lesions found, 12		
head, average price \$24.45, ...		293 50
for quarantine expenses, ...		70 70
for killing and burial expenses, ...		77 96
for arbitration expenses, ...		2 00
Total for 518 head, average cost per head \$27.36, . .		\$14,176 28
Paid for salaries of commissioners (to		
May 1), ...	\$2,875 00	
for salaries of agents (to May 1), ...	3,061 21	
for salaries of clerks and stenogra-		
phers, ...	2,206 16	
for expenses of commissioners (to		
May 1), ...	1,458 24	
for expenses of agents (to May 1), ...	2,092 36	
for expenses of office, ...	913 57	
for expenses of laboratory and ex-		
perimental work, ...	563 10	
for expenses of quarantine stations		
(to May 1), ...	1,325 55	
for expenses of glanders (killing and		
burial), ...	87 60	
		14,582 79
Total payments, ...		\$28,759 07

Of the above amount, the sum of \$9,296.67 was for payment of claims and accounts of 1897.

Cash received and turned over to State Treasurer:—

For hides and carcasses, ...	\$625 58
For ear tags, ...	532 46
For use of telephone, ...	1 00
Total, ...	<u>\$1,159 04</u>

The amount due and unpaid at the time of making this report includes bill of Dr. L. Frothingham for microscopic examinations and tests for glanders, rabies, etc., from May 4 to December 15, ...	\$140 75
J. W. Hitchings, services and expenses at quarantine stations from June 28 to December 15, ...	99 50
A. D. Phelps, services and expenses at quarantine stations from July 4 to December 15, ...	70 46
Chas. H. Perry, examination of glanders cases and auction sale stables from May 7 to December 15, ...	83 66
Office expenses, clerks and stenographers, ...	61 32
Total, ...	<u>\$455 69</u>

The salaries of the commissioners and the amounts expended by them for travelling expenses, etc., remain unpaid, amounting to	\$4,128 73
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Six animals have been condemned and killed for which no claims have been filed.

On May 14, no more money having been appropriated by the Legislature, the Board consulted the Attorney-General's office as to their duties in the matter. As a result, the following circular letter was sent to each local inspector, for the purpose of putting a stop to the quarantining of animals by them:—

BOSTON, May 16, 1898.

DEAR SIR:—We quote below an opinion from the Attorney-General's office, relative to animals suffering with tuberculosis:—

No appropriation having been made for carrying out the provisions of the law relating to contagious diseases among domestic animals, the Cattle Commissioners are not obliged to do anything which the law commands them to do; but a peculiar state of facts exists, to wit, that an inspector appointed by the mayor and aldermen of a city or selectmen of a town, and paid by the city or town, is obliged to quarantine any domestic animal, if he suspects it is afflicted with a contagious disease, and that animal has to remain in quarantine until released by the

board of health of the city or town by which he is confined or by the Board of Cattle Commissioners, and the expense after ten days is to be borne by the Commonwealth. No money having been appropriated, the Commonwealth could not bear that expense. But it is unnecessary to discuss the complication in which the law may land the inspectors. Having no funds, the Cattle Commissioners are thereby excused from further service. To make their position clear to the inspectors and boards of health throughout the Commonwealth, however, it seems to me that they should notify each board of health and each inspector that, no appropriation having been made for them, they will not be responsible for anything that the inspectors or boards of health may do. They should also notify the inspectors and boards of health that, so far as they, the commissioners, are concerned, they release all cattle from quarantine. If the boards of health and inspectors then retain the cattle in quarantine, they do so at their own peril.

The above refers only to suspected cases of tuberculosis, as the statute provides for compensation for such animals; but it does not mean that the inspection of slaughter houses is to be discontinued, or that other suspected cases of contagious diseases shall not be reported to this Board.

Per order Massachusetts Cattle Commission,

AUSTIN PETERS, *Chairman*.

During the month of June the Legislature having adjourned without having made any further appropriation, the chairman was instructed to find out what duties were expected of the commissioners; consequently, after consultation with His Excellency the Governor, the following letter was sent to the Attorney-General:—

Boston, June 25, 1898.

Hon. HOSEA M. KNOWLTON, *Attorney-General, State House, Boston*.

SIR:—The Legislature having adjourned after failing to make a sufficient appropriation for the use of the Cattle Commission, and at the same time not having repealed the law as relating to contagious diseases among animals, I write to ask you for an opinion as to whether the Cattle Commissioners shall attempt to perform their duty during the rest of the year, or any portion of their duty which would require no expenditure of money further than the expense of the commissioners' compensation and their actual travelling expenses.

The only animals which the law contemplates paying owners for are cattle condemned as afflicted with the disease of tuberculosis, and then only cattle that have been owned within the State six months.

Horses suffering with glanders the law says must be killed, but the owner is not entitled to compensation unless the animal is found healthy on post-mortem. In addition to glanders and tuberculosis, the diseases which we may meet with are outbreaks of rabies and hog cholera; and possibly Texas fever, during the summer months, might be imported into the State, although the danger of this is slight.

The Board of Cattle Commissioners has for the last three or four years required all neat cattle brought into the State, over six months old, unless for immediate slaughter, to be tested with tuberculin. This requires the granting of permits from this office for people who wish to bring in cattle from without the State; also it is necessary that some member shall be at Somerville, Watertown and Brighton two or three days during the week, while markets are being held there. The testing of these cattle and requiring people to have permits to bring cattle into the State is not a matter of general law, but it is one of the rules and regulations of the Board of Cattle Commissioners.

The act providing for the compensation of the Cattle Commissioners is chapter 378 of the Acts of 1885, which reads: "The compensation of such commissioners shall not exceed five dollars a day for actual service, in addition to their travelling expenses necessarily incurred." It further says that: "The Board of Cattle Commissioners, appointed under chapter 378 of the Acts of 1885, shall perform the duties previously performed by the Board of Cattle Commissioners which existed until the end of September, 1885." I have not looked up the laws under which the Board was appointed prior to Oct. 1, 1885, or their duties prior to that time.

The Legislature this year has passed a bill appropriating \$10,000 to reimburse towns, whose valuation is less than two and one-half million dollars, for one-half the amount of expense incurred in compensating inspectors of animals and provisions. The present Legislature has also passed an act, approved May 23, 1898, saying that the work of preventing the spread of contagious diseases among domestic animals shall be performed, and the appropriation therefor be expended, by local inspectors acting under the direction of the Cattle Commissioners as far as possible. Section 2 of this same act provides that the Board of Cattle Commissioners may issue rules and regulations for the guidance of inspectors of animals and provisions in the inspection of meat.

The Legislature also appropriated \$20,000 for the current expenses of the Cattle Commission until such time as they decided

whether to make a further appropriation or not. The House ways and means committee reported a bill making a further appropriation of \$65,000 the end of April, which was defeated. As we have but very little of the \$20,000 left, if the members of the commission sent in their bills for services that they have already rendered, there would be a deficit now.

I would like to know whether the commission should cease to perform its duties and lock up its office altogether, or whether it should remain organized, keep its office open here and do what it can. I would be very much obliged for an early reply, as I wish to see the Governor in relation to the matter Monday morning, and ascertain his views on whether we shall attempt to keep our work up or not.

Very respectfully,

AUSTIN PETERS, *Chairman*.

The Attorney-General's reply was as follows : —

Boston, July 2, 1898.

AUSTIN PETERS, *Chairman*.

DEAR SIR : — Your letter of the 25th ult. calls attention to the fact that no appropriation for the expenses of your commission has been made by the present Legislature, and requires the opinion of the Attorney-General upon the question “ whether, in view of that fact, the commission should cease to perform its duties and lock up its office altogether or whether it should remain organized, keep its office open and do what it can.”

With one or two exceptions, not necessary now to consider, no money can be paid from the treasury of the Commonwealth to any person whatsoever without a specific appropriation therefor by the Legislature. The officers of government hold their positions in view of the general statutes relating thereto, which fix their duties and establish their salaries. Such general laws, however, do not of themselves authorize the payment of the salaries so established, or of the incidental and necessary expenses incurred in the discharge of the duties of such officers. For these an appropriation must annually be made by the Legislature. This principle extends throughout every department of State government. It is in recognition of the fundamental principle that the amount of expenditure for governmental purposes, and the consequent tax levy therefor, is, and in a republican form of government necessarily must be, within the immediate and direct control of the representatives of the people. Even judgments of the courts in civil proceedings against the

Commonwealth cannot be paid without a special appropriation therefor. (Pub. Sts., c. 195, § 4.)

It is, moreover, expressly provided by Pub. Sts., c. 16, § 37, that: "No public officer shall make purchases or incur liabilities in the name of the Commonwealth for a larger amount than that which has been appropriated by law for the service or object for which such purchases have been made or liabilities incurred; and the Commonwealth shall be subject to no responsibility for the acts of its servants and officers beyond the several amounts duly appropriated by law."

The Legislature having deliberately and repeatedly refused to make further appropriation for the conduct of the business of your commission, you are thereby relieved from the performance of such of the statutory duties devolved upon you which involve the incurring of liability to be paid by the Commonwealth. By the positive provisions of the statute above quoted, you have no right to do any acts whatsoever which call for the expenditure of the money of the Commonwealth. The general statutes applicable to your commission imposing duties upon your Board are to be construed in connection with and are limited by the statute I have quoted. For example, it is made your duty to cause horses afflicted with glanders to be killed. In so far as this duty may require the expenditure of money, you have no right, in view of the action of the Legislature, to perform it; and the failure of the Legislature to furnish money for the purpose is to be regarded by you as abrogating any duty imposed upon you in that respect. Although by general laws you have been made the agents of the Commonwealth to do certain acts, your agency has been by implication revoked by the failure of the Legislature to furnish you with money for that purpose.

The foregoing considerations apply to such portion of your duties as involve the expenditure of money. The failure, however, to make an appropriation does not repeal the law establishing your Board and its duties, except as hereinbefore stated, nor that which fixes your compensation. You are still sworn officers of the Commonwealth, duly constituted, charged with the performance of the duties thereof, so far as the same can be performed without the expenditure of money or the incurring of liability on behalf of the Commonwealth, and entitled to the compensation fixed by law for your services. No appropriation having been made you cannot at present receive your salary. Your claim, like all other claims against the Commonwealth, depends for its payment upon legislative appropriation, and you have no other security that it will be paid than your reliance upon

the sense of justice of the General Court. As I have already intimated, no officer and no creditor of the Commonwealth stands upon a better title. With the exception of the Governor and the justices of the supreme judicial court, no officer of the Commonwealth, however elected or appointed, can receive the compensation fixed by law for his office until the amount has been appropriated by the Legislature. Nor can any person having a claim against the Commonwealth, however just, enforce its payment otherwise than by the grace of the General Court.

The failure of the Legislature to make appropriation for your work does not require you to abdicate your offices nor to give up the performance of your duties, excepting in the cases where liability in behalf of the Commonwealth may be incurred. On the contrary, it is the duty of your commission to continue to hold their offices, and to perform the duties thereof, so far as may be, with the expectation that at some future time the Legislature will authorize payment therefor. If you are not willing to continue in office under these conditions, it is your duty to resign.

Yours very truly,

HOSEA M. KNOWLTON, *Attorney-General*.

On receipt of this reply a meeting of the Board was held, when it was decided to keep up the quarantine on out-of-State cattle, and, as instructed by the Attorney-General, to continue the work of the Board except in so far as it related to the condemnation of animals affected with bovine tuberculosis.

During the remainder of the year, notwithstanding the instructions that had been sent out by the commissioners, 83 animals have been placed in quarantine by the inspectors as being tuberculous; in every case these animals have been immediately released. The commissioners have also knowledge of a number of animals that have been kept in confinement by their owners, in the expectation that compensation would be granted another year.

During 1897 an effort was made to impress on the owners of cattle the necessity for thorough disinfection and cleanliness in the barns; and, believing in the importance of this measure, the following circular letter was drawn up for distribution, and sent to persons who had received compensation from the State:—

BOSTON, Oct. 18, 1898.

DEAR SIR: — In view of the fact that you have had tuberculous animals in your herd, and your barn in consequence having become an infected barn, and in view of the difficulty of thoroughly disinfecting premises that have once been infected by tuberculous cattle, the Board of Cattle Commissioners would advise that you should again thoroughly cleanse, disinfect and whitewash your premises, as directed last year. In this way the possibility of danger from the presence of any infectious material that may have been overlooked, or that may have been brought into the barn since last disinfected, will be much reduced.

The Board further desires to impress on all owners of cattle, that to secure the best results the Board should have the hearty co-operation and assistance of the individual owners; and that assistance can best be given by seeing to it that not only must the premises previously occupied by diseased cattle be thoroughly and frequently cleansed and disinfected, but (as suggested in the annual report, published January, 1898) it is always of the greatest importance, whether tuberculosis has existed in the herd or otherwise, that pains be taken to improve the light, drainage and ventilation of all barns, and to allow only animals known to be healthy to mix with the balance of the herd already in the barn; in this way the gains made during the last few years will be maintained, and gradually a better condition of affairs will result.

AUSTIN PETERS, *Chairman*,

JOHN M. PARKER, *Secretary*,

MAURICE O'CONNELL,

LEANDER F. HERRICK,

CHARLES A. DENNEN,

Board of Cattle Commissioners.

Incidentally the great value of insisting on the cleaning and disinfection of barns is shown in another direction by a statement made by the Boston milk contractors, that less milk had been spoiled and returned to them during the past year than ever before; this is attributable in part at least to the greater cleanliness in the barns.

The law further provides that inspectors must be present at all licensed slaughter houses or establishments upon the day or days designated for slaughter (section 20, chapter 491 of the Acts of 1894, as amended by section 6, chapter

496 of the Acts of 1895); and also that "Every inspector shall keep a record of all inspections made by him and his doings thereon, and shall make regular returns of all such inspections to the Board of Cattle Commissioners"(section 5, chapter 491, of the Acts of 1894). Under this provision the inspectors of various towns and cities have reported the following work:—

Inspected at licensed slaughter houses at time of slaughter:—

Cattle (including calves), ...	120,416	
Sheep, ...	388,933	
Swine, ...	1,411,304	
Total, ...		1,920,653

Inspected at time of slaughter, under section 21:—

Cattle (including calves), ...	1,586	
Sheep, ...	113	
Swine, ...	4,679	
Total, ...		6,378

Total reported inspections at time of slaughter, . . .		1,927,031
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Animals destroyed as tuberculous:—

Cattle, ...	241
Sheep, ...	—
Swine, ...	65

Condemned for other causes:—

Cattle, ...	2
Calves under four weeks old, ...	71
Sheep, ...	—
Swine, hog cholera, ...	9
Number of towns reporting licensed slaughter houses, ...	72
Number of licensed slaughter houses reported, . . .	183

It may be of interest to notice that the change in the law relating to meat inspection, recommended by the Cattle Commission under section 2 of chapter 451 of the Acts of 1898, gave the Board of Cattle Commissioners power to "make and issue rules and regulations for the guidance of inspectors of animals and provisions, in the inspection of meat, which shall conform to the rules and regulations of the United States Bureau of Animal Industry for the inspection of meat for export and interstate commerce."

In accordance with that law, on July 14, 1898, the following rules and regulations were adopted, and ordered printed for distribution : —

Boston, July 14, 1898.

To Inspectors of Animals and Provisions.

Under section 2 of chapter 451 of the Acts of 1898, the Board of Cattle Commissioners has been given power to “make and issue rules and regulations for the guidance of inspectors of animals and provisions, in the inspection of meat, which shall conform to the rules and regulations of the United States Bureau of Animal Industry for the inspection of meat for export and interstate commerce.”

In pursuance of the foregoing, the Board of Cattle Commissioners do hereby issue the following rules and regulations for the guidance of inspectors of animals and provisions, in their examination, at the time of slaughter, of all neat cattle, sheep and swine : —

1. The carcasses of all animals, found on examination to be affected with any of the following, are to be condemned : —

- (1) Hog cholera.
- (2) Swine plague.
- (3) Charbon or anthrax.
- (4) Rabies.
- (5) Malignant epizootic catarrh.
- (6) Pyæmia and septicæmia.
- (7) Mange or scab, in advanced stages.
- (8) Advanced stages of actinomycosis or lumpy jaw.
- (9) Inflammation of lungs, intestines or peritoneum.
- (10) Texas fever.
- (11) Extensive or generalized tuberculosis.

(12) Any disease or injury causing elevation of temperature, or affecting the system of an animal to a degree which would make the flesh unfit for human food.

2. When any carcass, on examination by the inspector, is found to be unfit for food, it shall be rendered or buried, or otherwise made unsalable for human food.

AUSTIN PETERS, *Chairman*,
JOHN M. PARKER, *Secretary*,
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,

Board of Cattle Commissioners.

The second portion of the work, the examination of all cattle coming from without the State for sale in the markets of Brighton, Watertown and Somerville, has been continued through the year, thus preventing the distribution of untested animals, and providing a market where those desiring so to do have been enabled to secure tested stock.

Receipts of stock at these three stations during the year to December 15 have been as follows : —

At Brighton.

Maine cattle, ...	10,907
New Hampshire cattle, ...	1,356
Massachusetts cattle, ...	10,042
New York cattle, ...	487
Western cattle, ...	44,906
Sheep, ...	43,961
Swine, ...	732,302
Calves, ...	30,264
Horses, ...	4,125
Cattle released on certificates, ...	11,410
Cattle tested, ...	105
Cattle released after test, ...	104
Cattle condemned after test, ...	1

At Watertown.

Vermont cattle, ...	5,908
New Hampshire cattle, ...	6,974
New York cattle, ...	143
Massachusetts cattle, ...	1,226
Western cattle, ...	112,248
Sheep, ...	450,989
Swine, ...	735,399
Calves, ...	46,283
Horses, ...	18,975
Cattle released on certificates, ...	7,177
Cattle tested, ...	42
Cattle released after test, ...	41
Cattle condemned after test, ...	1

At Somerville.

Maine cattle, ...	572
New Hampshire cattle, ...	3,120
Vermont cattle, ...	1,566
Massachusetts cattle, ...	3,261
New York cattle, ...	540
Western cattle, ...	70,405
Sheep, ...	367,352
Swine, ...	18,173
Calves, ...	35,261
Cattle released on certificate, ...	799
Cattle tested, ...	115
Cattle released after test, ...	112
Cattle condemned after test, ...	3

Total received at the Three Stations.

Cattle, ...	273,661
Sheep, ...	862,302
Swine, ...	1,485,874
Calves, ...	111,808
Released on certificates, ...	19,386
Tested at stations, ...	262
Released after test, ...	257
Condemned after test, ...	5

Besides these, 7,597 cattle have been admitted from without the State to other points than these stations, and have been tested either before or after arrival.

It would seem to be almost unnecessary at this time to attempt to show the great importance of exercising some State supervision over bovine tuberculosis. Most governments throughout the world are taking steps to place this disease under State control. Great Britain has spent a lot of money, first on the "Royal Commission on Tuberculosis," when investigations and experiments were carried on under the direction of the commission for nearly three years; and, later, on their making their report, a second Royal Commission was appointed, to inquire into the administrative pro-

cedures for controlling the danger to man through the use of meat and milk of tuberculous animals. This second commission was appointed in July, 1896, and after nearly two years' work it made its report on the thirty-first day of March, 1898.

In this report the commission confined itself mainly to two branches, "namely, the prevention of the infection of human beings, from (*a*) the consumption of meat affected with tuberculosis and (*b*) from the consumption of milk drawn from tuberculous cows."

They refer to the report of the Royal Commission on Tuberculosis, which reported in 1895, to the effect that: —

Tuberculous disease in bovines is identical with that in the human subject, and that it is communicable from one to the other, though the manifestations of the disease differ in some respects in the human from that in the lower animals.

Then they continue: —

We have also considered their finding, that "any person who takes tuberculous matter into the body as food incurs risk of acquiring tuberculous disease." . . . Nothing that has come before us in the course of our inquiry has raised any doubt in our minds as to the accuracy of this opinion.

The reference in the report to tuberculin is an important one. It is more especially interesting, as it corresponds so closely to the experience of the Massachusetts Board in this direction. In section 13 they say: —

We have felt that the value of our report, and any recommendations which we can base upon it, must depend, in very large measure, on the degree in which accumulated experience has justified confidence in the tuberculin test, not only among veterinary experts, but among stock owners and persons engaged in the milk trade. We have therefore directed very special and searching inquiry into this matter. Only one witness, a Yorkshire dairy farmer, expressed any doubts on the matter, and even he, while thinking that it "was not altogether reliable," believed it to be "fairly accurate." In Berlin, in Copenhagen, in London and other places where the action of tuberculin has been made a spe-

cial subject of study, we found a general consensus of opinion as to the efficacy of the test. Perhaps we may best render our own impressions by quoting the evidence of Professor McFadyean, given before us, showing that all doubt on the subject had been removed from his mind since his experiments were carried out at the request of the former commission: "No person, whether he were a layman or a veterinary surgeon, when summoned to look at an animal suspected of showing symptoms of tuberculosis, could give an opinion that was really of much value in the great majority of cases unless he used tuberculin. We have all recognized that within recent years. If the animal is in the very last stage of the disease, one may make a diagnosis that has little chance of error, but in the great majority of cases it is only a guess. With tuberculin it is practically a certainty. I should like, if I am not going too fully into that, to give evidence regarding the reliability of tuberculin as a test. I made a number of experiments on that, and reported them to the previous Royal Commission. These, however, were not entirely favorable to the use of tuberculin, because in a considerable proportion of cases the indication afforded by the tuberculin was wrong. But, since that, experiments and observations made in somewhat different circumstances have yielded entirely different results, and I have the most implicit faith in tuberculin as a test for tuberculosis, when it is used on animals standing in their own premises, and undisturbed. It is not a reliable test when used on cattle in a market, or on any cattle that have been shipped, or trained, or otherwise excited. That has been found out since I made my report. Other observers have had similar results under similar circumstances. Unfortunately, the Royal Commission set apart a very small sum to test this question of diagnosis; I think it was £100. Tuberculin was only newly introduced then, and I could not get anybody who would submit his cows to the test. It was only through the kindness of Professor Brown, who allowed me to use the test on animals condemned under the pleuro-pneumonia slaughter order, that I was able to make the test. I got these animals in slaughter houses, and, after they had been trained, or otherwise brought there, tested them. Then they were killed next day, and a considerable proportion of errors were found. But since that, using it on animals in their own premises, I have found that it is practically infallible. I have notes here of one particular case that I might put in, where in a dairy twenty-five animals in all were tested, and afterwards they were all slaughtered. There was only one animal that did not react, and it was the only animal not tuberculous when they were killed." We en-

tirely accept these conclusions, and entertain no doubt as to the value of tuberculin, provided the test is applied by a competent veterinary surgeon, and that the tuberculin is of a trustworthy quality.

With regard to the prevalence of tuberculosis, they quote the returns from slaughter houses in Leipzig, where there is careful inspection of all animals slaughtered. In 1895 the records are as follows :—

KIND OF ANIMAL.	Number Slaughtered.	Number Tuberculous.	Per Cent.
Oxen, ...	8,454	2,379	28.14
Heifers, ...	1,071	217	20.35
Cows, ...	9,303	4,048	43.51
Bulls, ...	4,090	975	23.83
Totals, ...	22,918	7,619	33.24

As showing how much more prevalent the disease is in some districts than others, they refer to a test of a herd of 90 cows in Cheshire, resulting in 70 reactions, all but 20 suffering from tubercular disease (77 per cent.). “Of six herds in the same neighborhood, 63 per cent. were found affected. On the other hand, a herd of 100 Jerseys in Sussex was tested without obtaining a single reaction.”

With regard to meat inspection they refer to different methods in different parts of the country, and then they say :—

The question then arises, Has such a stage of experience and knowledge been attained, as to the nature of tuberculosis and the effect of tuberculous meat upon the human consumer, as to enable a uniform standard to be prescribed for the guidance of meat inspectors? We believe that such a stage has been attained.

Assuming that seizure of meat should be strictly confined to such as is dangerous to human health, we entertain no doubt that in certain places a great deal of meat is seized which is perfectly safe and wholesome food.

When, some years ago, tuberculosis in human beings and other animals was first proved to be interchangeable, we think that an exaggerated view was taken of the extent of the danger arising

from meat, and that this view is still acted upon in certain places. Undoubtedly we are not prepared to recommend that indiscriminate traffic in tuberculous meat should be permitted, or that inspection should be more lax than it is at present. On the contrary, we strongly urge that inspection should not only be more general and systematic, but that all inspectors should be qualified by special training. We hold, however, that it should be conducted on better-defined principles, and that some limit should be observed in the latitude permitted to medical or veterinary officers in fixing independent standards of soundness in different places.

In making suggestions, they say they kept in mind the remarkable returns of the rigid but discriminating inspection in 29 towns in Saxony in 1895. Meat inspectors in these towns were all qualified veterinary surgeons. Tuberculosis was found to exist in 22,758 carcasses (being 27.48 per cent. of the whole number slaughtered). The whole of them, according to the practice of some authorities, would have been confiscated and destroyed without compensation; but in Saxony they were dealt with as follows: of the total number of 22,758 carcasses showing tuberculous lesions, 21,062, or 91½ per cent., *were passed as fit for food*; 1,256, or about 5½ per cent., were disposed of as inferior meat, at a fixed cheap rate; the remainder, 440 carcasses, or 2 per cent., were condemned and destroyed.

With regard to public slaughter houses they say:—

It is scarcely necessary to point out how greatly the exclusive use of public slaughter houses contributes to efficiency and uniformity of inspection. Naturally those who have vested interests in private slaughter houses object to interference with their property. But instances might be given in which these objections have been satisfactorily overcome. The municipality of Glasgow, for example, erected public slaughter houses more than forty years ago, before they had obtained power to suppress the private establishments. They admitted owners of these establishments to the use of the public slaughter houses, compensating them for the closing of their premises by charging them lighter dues than others who had lost nothing. There was no dissatisfaction, and the butchers now express a strong preference for the public slaughter houses over the old system. So long as private slaughter houses are permitted to exist, so long butchers, from use and wont, will continue to use them, and so long must inspection be

carried on under conditions incompatible with efficiency, besides other disadvantages and risks to health which lie beyond the scope of our reference.

With regard to the milk supply they report : —

Whatever degree of danger may be incurred by the consumption of the flesh of tuberculous animals (and we have already stated our belief that the tendency in this country has been rather to exaggerate than to underrate it), there can be little doubt that the corresponding danger in respect to milk supply is a far greater one.

Then they say further : —

It has been proved to our satisfaction, from the returns of medical officers of health and meat inspectors, that tuberculosis prevails to a larger extent among dairy stock than in any other class of animal. Considerable difference of opinion exists among experts as to the extent to which a cow may be affected with tuberculosis without rendering her milk dangerous. It was not proved to our satisfaction that tubercle bacilli had ever been detected in milk, unless drawn from a cow with tuberculosis of the mammary gland. In that case the disease generally, but not always, manifests itself by external signs, and the udder is suspected to be tuberculous. It is obvious, we think, that milk drawn from such a source ought to render him who exposes it for sale liable to heavy penalties. But there is no power at present to prevent such milk being sold. Professor McFadyean told us that, in a sample of milk from a diseased udder submitted to him for diagnosis, he had no difficulty in detecting tubercle bacilli; yet the milk from that cow continued to be sent in for sale in a neighboring city. Unfortunately, tuberculosis of the udder can rarely be differentiated from other forms of udder disease by the ordinary stock owner or dairyman, and hence all udder diseases should be forthwith notified to the local authority.

The opinion quoted by the first Commission on Tuberculosis (1894) is then recalled to the effect that : —

“The spread of tubercle in the udder” is apt to proceed with rapidity, that it may be manifested and become distinctly developed “between fortnightly inspections carried on along with a veterinary surgeon,” and that “the very absence of any definite sign in the earlier stage is one of the greatest dangers of this condition.” And, having regard to these circumstances, the

commission also report that both Dr. Martin and Dr. Woodhead, who carried out the experimental researches in this matter, "insist that no tuberculous animal of any kind should be allowed to remain in a dairy."

We concur generally in the views expressed, but, having regard to the extent to which tuberculosis exists among milch cows, and to the absence of evidence that danger of conveying tuberculosis arose from the use of milk as a food apart from the existence of tubercular disease of the udder, we are of opinion that direct action for the elimination of all tuberculous cows from dairies should proceed tentatively. There are, however, directions in which action should be taken at once. These are: (1) systematic inspection of the cows in dairies and cow sheds by the officers of the local sanitary authorities within whose district the premises are situated; (2) inspection when desired of the cows in any dairy or cow shed, wherever situated, by the authorized officers of local authorities within whose districts milk from the premises in question is supplied; (3) power for a medical officer of health to suspend the supply of milk from any suspected cow for a limited period pending veterinary inspection; (4) power to prohibit the sale of milk from any cow certified by a veterinary surgeon to be suffering from such disease of the udder as in his opinion renders the animal unfit for the supply of milk, or exhibiting clinical symptoms of tuberculosis; (5) the provision of a penalty for supplying milk for sale from any cow having obvious udder disease, without the possession by the owner of a certificate to the effect that such disease is not tubercular.

In considering the elimination of bovine tuberculosis, they discuss fully Bang's method of handling this disease. Tuberculin, he believes, gives trustworthy results in over 90 per cent. of the animals tested, and in the great majority of those which react the test reveals only latent tuberculosis. Shortly stated, Bang's method is as follows: he separates the sound from the reacting animals, feeding the calves born, from the first day of life, on boiled milk, submitting once or twice a year the healthy animals to a fresh test, placing such as react on the further side of the partition, and purchasing only animals that have stood the tuberculin test. In this way a healthy herd may take the place of one that had been markedly diseased. The milk of reacting animals is used in the dairy. Of course cows showing physical evidence of disease are destroyed.

The following table, furnished by Bang, shows the number of reacting animals in Denmark : —

	Number of Herds.	Sound Animals.	Reacting Animals.	Per Cent. of Disease.
Jutland, ...	2,721	43,479	23,311	34.9
Fyen, ...	1,355	22,770	7,302	24.3
Zeeland, ...	662	13,026	9,903	43.2
Moen, ...	82	1,313	629	32.4
Lolland-Falster, ...	198	6,248	2,497	28.5
Bornholm, ...	588	12,065	2,257	15.8
Total, ...	5,306	98,901	45,899	31.7

Out of the 5,306 herds, 1,132 were found completely free from disease, no single animal reacting.

The report then concludes : —

We further believe that, by disseminating sound information as to the method of detection and the measures to be taken for isolation, and by distributing tuberculin gratuitously or at a low cost, tuberculosis may be considerably reduced, possibly to an extent which would prevent any serious loss to stock owners or any important interference with the cattle trade.

The recommendations of the Royal Commission may be summed up as follows : —

Meat.

Animals should be slaughtered for beef only in public slaughter houses, where they can be properly inspected.

No person should be permitted to act as inspector until he has passed a qualifying examination.

Instructions should be issued from time to time for the guidance of inspectors, prescribing the degree of tubercular disease which should necessitate the seizure of a carcass.

Milk.

They recommend that the notification by the owner of any disease of the udder should be made compulsory.

That, for the purpose of excluding the milk of cows affected with tuberculosis of the udder, or exhibiting symptoms of the disease, authorities should be given power to slaughter such cows, subject to compensation.

That authorities should oversee the condition of the barns or cow sheds, which should include the following : —

1. An impervious floor.
2. Sufficient water supply for flushing.
3. Proper drainage.
4. Depot for manure at sufficient distance from byres.
5. Minimum cubic contents of from 600 to 800 for each adult beast.
6. Minimum floor space of 50 feet to each adult beast.
7. Sufficient light and ventilation.

For the elimination of bovine tuberculosis the commission recommends that on certain conditions a gratuitous supply of tuberculin, together with the services of a veterinary surgeon, be given stock owners. These conditions are : —

1. That the test be applied by a veterinary surgeon.
2. That tuberculin be supplied only to such owners as will undertake to isolate reacting animals from healthy ones.
3. That the stock to be tested shall be kept under satisfactory sanitary conditions, and more especially that sufficient air space, ventilation and light be provided in the building occupied by the animals.

These are the principal points recommended by the Royal Commission in its two years' sitting; and, although arrived at entirely independently, they come to the same conclusion and embody the main points of the best laws on this subject in European countries. (For synopsis of these European laws, as well as laws of the various States in America dealing with this subject, see Appendix.)

As pointed out by Bang, nowadays when a person refers to a herd as being tuberculous, the idea conveyed to the professional mind is entirely different from what it would have been a few years ago. The use of tuberculin has completely revolutionized our ideas on the subject of tuberculosis. We now know that incipient cases or cases of elementary infection are exceedingly common, and, as is natural, they are most general where there is a lot of trading and shifting of cows. This occurs most commonly of course in the dairy centres, the infected dairy barns gradually becoming centres

of infection, from which the disease is distributed in a varying degree of prevalence throughout the country.

In Europe, being an older country, and the raising of special breeds having reached a higher state of development at an earlier period than in this country, tuberculosis was exceedingly prevalent long before any importance was attached to it here. As illustrating the method of its spread to the United States, the story was recently told, by a gentleman of large experience, that many years ago a veterinary practitioner went over to Scotland on a visit; before leaving here he was asked by a friend to select several cows of a certain breed for shipment to this State. On his arrival he visited a celebrated stock farm, where he made a selection, and the sale was almost completed, when one day he received a visit from a fellow veterinarian, practising in that district, who told him that he knew the herd to be badly affected with tuberculosis, and that he did not feel justified in allowing him to ignorantly buy the cattle and infect the stock in Massachusetts. This incident is related as showing both the method of its spread to this country, and how, even at that time, before its actual cause was known, the infectious nature of tuberculosis was realized and dreaded by those who were familiar with its character.

The percentage of infected animals in almost all European countries is very high; in Leipzig, out of 22,918 cattle slaughtered for beef, 7,619 were found to be tuberculous, a percentage of 33.24. In 29 different towns in Saxony, out of over 84,000 cattle slaughtered for beef, 27.48 per cent. were found tuberculous, as has already been noticed. In Denmark the percentage of infected animals in various herds in different districts varied from 15.8 to 43.2 per cent., with a total percentage in 5,306 herds, including 98,901 sound animals and 45,899 reacting animals, of 31.7. In Great Britain, as in other places, it is more prevalent in some districts than others. In Cheshire, for example, in a herd of 90 cows, 70 were found to be infected, a percentage of 77 per cent., while in 6 herds in the same neighborhood 63 per cent. were found to be infected. Of 12,000 cattle slaughtered in England for contagious pleuro-pneumonia, 12 per cent. were found to be infected with tuberculosis.

In the United States the percentage of disease is generally low, although in certain districts it approaches the high rate of European countries. In Maine the percentage of rejected animals is about 0.93 per cent.; in Vermont, about 2.41 per cent.; in New York, about 4.32 per cent.; and in New Hampshire, about 10.39 per cent. In these cases of course the percentage is based on the number rejected for shipment to Massachusetts; and, as presumably only apparently healthy animals are tested for the purpose of export, this percentage is probably lower than the actual amount of infection.

In Massachusetts the percentage of disease averages a good deal higher. In the fall of 1894, 28 herds, scattered over different towns, were tested, these including 660 cattle. Of these, 188 were condemned, showing a percentage of 28.48. About the same time some 12 or 15 herds in Middlesex County were tested, these including 312 animals, and of these, 34, or 10.89 per cent., were found infected.

From June 5 to Dec. 15, 1895, herds including 4,095 animals were tested; of these, 1,081, or 26.4 per cent., were found to be tuberculous. In 1897, 157 herds, including 2,413 cattle, were tested; of these, 1,397, or 53.79 per cent., were found to be infected animals. A general percentage of all the herds tested in Massachusetts would include 7,480 animals; of these, 2,600, or 34.75 per cent., were found to be infected.

As has already been noticed, most infected animals are found in the milk-producing, and, therefore, in the infected, districts; and, while probably the general average throughout the State is slightly lower than in these districts, yet the general average of infection is high.

Fortunately, by far the larger proportion, probably 75 or 80 per cent. of these cases, are slight localized cases; but it is no use hiding the fact that these animals are infected animals, and, placed under proper conditions, in any one of them the disease might develop and the animal become a diseased animal. It is the duty of the State, then, to spread information, and educate and assist the owners of stock to place their cattle under such conditions as to assist in retarding the possible development of these infected but not affected

cattle. It would be well also to encourage those who desire to entirely free their herds from disease to follow the principles for handling infected herds laid down by Bang. If this were done thoroughly and conscientiously by owners of such stock, it would do much to reduce the amount of disease in the State, and it would cost but a fraction of the amount required for the total destruction of infected animals. Such a plan would only necessitate the destruction of such animals as show physical evidence of disease, — the slight localized cases are not necessarily dangerous; on the other hand, the cases showing clinical evidence of disease, whether disease of the udder or otherwise, are the cases that need immediate attention. These are a source of danger to both human beings and the other cattle in the barn, and should be taken care of immediately.

In this connection Prof. Theobald Smith tersely and concisely reviews the situation when he says: —

It seems to me that, accepting the clinical evidence at hand, bovine tuberculosis may be transmitted to children when the body is overpowered by large numbers of bacilli, as in udder tuberculosis, or when certain unknown favorable conditions exist. To prevent this from occurring, a rigid periodic dairy inspection and the removal of all suspicious udder affections and all emaciated animals is as much as public health authorities can at present demand. Any measures beyond these belong to agriculture, with which the public has no business to meddle, without endangering the chances of gaining authority to enforce its own necessary measures. If the evidence gained by pathology in the future should reveal a greater danger than is here assumed, the scientific basis of such evidence will, I think, force all additional measures needed.

This conclusion of Smith's coincides remarkably with the careful and conservative opinions expressed by the Royal Commission, which was appointed by the British government to investigate and report on the best procedures for controlling the dangers to man from bovine tuberculosis. In summing up, the report states: "We recommend that, for the purpose of excluding from their districts cows affected with *tuberculosis of the udder, or exhibiting symp-*

toms of disease, local authorities should be given power . . . to slaughter such cows, subject to compensation," etc.

So much for the protection of public health; then it proceeds to show how, as an agricultural measure, by adopting the principles of Bang's method stockmen can eradicate it from their herds.

It will be noticed that these practically embody the main features of the measures adopted in Belgium and other countries. They advise the condemnation of animals showing physical evidence of disease and disease of the udder; further than that they look upon it as a purely agricultural matter.

The question of the advisability of keeping up the quarantine on out-of-State cattle is one that has received a good deal of consideration. The difficulties in its enforcement are great, yet the benefits to the cattle industry and the State from its enforcement would seem to more than counterbalance whatever disadvantages there are. In reference to this matter a prominent drover remarked recently that all the dealers endeavored to get as good a class of animals as possible for the Massachusetts market; but when asked, "What would be the result in case the quarantine was abolished?" he remarked, "Why, we would bring in the animals we could get the most money out of."

New York to-day is suffering from just the condition that would confront Massachusetts if all quarantine was abolished. At a recent annual meeting of the New York State Veterinary Medical Society certain resolutions were adopted, a portion of which read:—

Whereas, There is no systematic work done by them [the New York Commission] in the suppression of tuberculosis in farm animals, but cattle brought from the west for shipment into the States east or south of New York and here tested by tuberculin are habitually separated into two lots, representing the sound and tuberculous; and that the sound (those that do not react) are shipped into New England and other States, while the tuberculous (the reacting) are sold into the herds of the State of New York, carrying destructive disease into our herds and a most dangerous infection into our meat and dairy products; therefore, be it

Resolved, That the New York State Veterinary Medical Society protests against such misappropriation of public funds, against the false show of protection to our herds and to the public health, while both are being sacrificed by the introduction into barns and fields of the cattle of other States *which have been rejected by other markets as tuberculous*.

On this same subject, in Bulletin 150, issued by Cornell University Experiment Station, Prof. James Law says : —

In recent years the rigid supervision of herds in the New England States has driven many infected cattle into New York, to spread tuberculosis in previously healthy herds and to increase it in those that were already affected.

The exclusion of cattle seeking to enter Pennsylvania or the New England States, which were not accompanied by the certificate that they had successfully stood the tuberculin test, has led to the testing of western cattle at Buffalo and elsewhere, and the detention of such as failed under the test, to be sold too often to the unsuspecting New York stock owner. The tests have often been made by the inspectors of the Bureau of Animal Industry, who have no legal right to interfere with the condemned cattle unless the attempt is made to move them into another State; and, in the absence of any restriction by the municipal or State health officers, the owner or dealer is at liberty to sell such tuberculous cattle in open market.

These are hints of the evils that have been precipitated for a length of time upon our New York live stock industry. Day by day our herds are being systematically infected by the introduction of the tuberculous offscouring of other States and of our own, and we raise not a finger to stop it.

The crying need of New York to-day is, first, to block these streams of infection, which are now practically invited into our herds from other Commonwealths; and, second, to inaugurate a systematic effort to rid our own herds, which are the sources of our dairy and meat products, from this scourge.

In the report of the New York State Board of Health the Board clearly outlines its position when it says : —

It would also seem just that the cost of ridding a herd of tuberculosis should be borne by the State only once, but that, thereafter, the owner should keep it free by admitting no animal without the proof of soundness, which the tuberculin test affords.

. . . *If, then, the tuberculin test be required for all cattle entering the State, the herds here once freed may be kept free from disease. . . . It is the purpose of the State Board of Health of New York to urge upon the Legislature of 1899 such revision of the existing laws upon this subject as shall ensure certainty in the detecting of the disease, free of cost to the owners of cattle.*

Pennsylvania also believes in quarantine work. In a recent letter Dr. Leonard Pearson, the secretary of the Pennsylvania Live Stock Sanitary Board, writes : —

I think that our present quarantine law is working satisfactorily and is very advantageous. It gets purchasers into the habit of looking for inspected cows, and it makes it possible for owners of healthy herds to purchase additions without going to the trouble and expense of having one or two cows examined. . . .

I think it is one of the most important features of any system looking to the suppression of tuberculosis in a State. Moreover, as farmers in the west and in other States learn more of tuberculosis, more and more infected cattle are being disposed of through the channels of commerce, and the States in which there is no inspection are being exposed to constantly increasing dangers.

And in the last annual report of the Vermont Board of Agriculture the Cattle Commissioners say : —

Quarantine regulations are in many respects inconvenient to stock owners and dealers, but they are a necessity in connection with any effort to control disease among our cattle. Evidence of this has come to us in many instances during the past year. We have found that cattle buyers from States where no quarantine was in force have purchased many suspected animals, at a price a little less than would have been paid if not suspected. While we have endeavored to have all work done on cattle going to States where a quarantine was in force performed with the same care and under the same rules as State work, and have demanded that all animals found diseased be turned over to us for slaughter, we have not felt it to be our duty to try and protect the interests of States that had no protection of their own.

Some time ago, for the purpose of answering certain practical questions incident to the routine work of the Board, the following letter was sent to the out-of-State veterinarians,

who have been known as engaged in testing cattle for importation into this State : —

DEAR DOCTOR : — As you know, our regulations require all cattle coming into Massachusetts to be tested with tuberculin before entering, or upon arrival. Knowing you have done some of the testing, and wishing to ascertain the value of the work and also to determine whether the number of animals rejected as diseased will warrant the expense of keeping up the quarantine, I take the liberty of sending you the enclosed blank, and ask you to kindly fill it out and return to me.

First, I wish to ask your opinion as to whether the buyers exercise their best judgment in purchasing only healthy animals.

How many cattle have you tested for Massachusetts?

How many of this number have reacted?

What disposition was made of those that reacted?

In your opinion, what is the per cent. of disease in your State, taking all herds together?

Yours truly,

C. A. DENNEN.

In response to this letter, reports have been received which show the following facts : —

STATE.	Number of Veterinarians Reporting.	Cattle Tested.	Cattle Rejected.	Per Cent.
New Hampshire, ...	14	15,713	1,634	10.39
New York, ...	14	5,503	238	4.32
Vermont, ...	14	7,157	173	2.41
Maine, ...	16	19,178	180	.93
Totals, ...	58	47,551	2,225	4.67

It is not supposed that this is a complete report ; but it is apparent that, if these 2,225 animals thus rejected had been imported into the State without inspection, and found diseased at a later period, it would have cost the State, at the rate heretofore paid for condemned cattle, about \$33.50 per head, the sum of \$74,537.50.

These figures also suggest the amount of selection exercised by the drovers of the different States in securing animals for this market, and that the State making the best showing in the above table may have still within its borders

an excess of diseased subjects. This is suggested by several of the replies from New Hampshire and New York, from which places the drovers bring into this State only such animals as have proved sound, while the suspects and condemned are left to infect other animals in their neighborhood and to contaminate the dairy products; but the benefits to this State are not confined alone to the rejection of reacting animals. The quality of *all* animals brought in for dairy purposes is improved.

On this same subject T. D. Babcock, one of the Cattle Commissioners in Rhode Island, in his report to the State Board of Agriculture of that State, in referring to this matter, says:—

It is but just to the reliable dealers in this locality to say that they do all in their power to carry out the provisions of the law. . . . That an enforcement of this law has made a marked improvement in the cattle in this section of the State, every well-informed person is free to admit.

Massachusetts is the general market for all the New England States, and the cost of the work is slight compared to the benefits to be derived from a steady prosecution of the work, even if it was to be abandoned by the other New England States.

Believing, then, that this or a somewhat similar method is necessary and for the benefit of all concerned, the order quarantining out-of-State cattle, and known as General Order No. 10, was revised; and finally, on the seventeenth day of October, 1898, the following order was adopted by the commission:—

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF CATTLE COMMISSIONERS,
COMMONWEALTH BUILDING, 11 MT. VERNON STREET,
BOSTON, Oct. 17, 1898.

To All Whom it may Concern.

By virtue of the power and authority in us vested by law, and especially under the provisions of chapter 491 of the Acts of the year 1894 and chapter 496 of the Acts of the year 1895, you are hereby notified that tuberculosis, which is a contagious disease and is so recognized under the laws of this Commonwealth, exists

among cattle of the several States and Territories of the United States, the District of Columbia and Canada; and such localities are, in the opinion of this Board, infected districts.

You are hereby further notified, that, in order to prevent the importation of diseased animals, and as a means of suppressing such disease within this Commonwealth, this Board has passed the following order:—

First.—No neat cattle brought from any State or Territory of the United States, the District of Columbia, Canada or any other country without the limits of this Commonwealth, shall be brought within the limits of this Commonwealth except for delivery directly to the Union stock yards in the town of Watertown, the Boston & Albany stock yards in Brighton, within the city of Boston, or the premises of the New England Dressed Beef and Wool Company in the city of Somerville, except upon a permit signed by the Board of Cattle Commissioners or some one of its members; and no neat cattle so brought for delivery at any of said points shall be unloaded, except in case of accident, at any point other than the said Boston & Albany stock yards in Brighton, the Union stock yards in Watertown, or the New England Dressed Beef and Wool Company in Somerville.

Second.—All neat cattle brought within the limits of this Commonwealth from any place designated in paragraph 1 hereof, except for delivery as provided in the preceding paragraph, must be accompanied by a permit issued by this Board or some member thereof; and you are hereby forbidden to receive for transportation animals other than those designated in such permit.

Third.—If for any cause any such neat cattle are received by any of your agents within the limits of this Commonwealth at any place other than the Union stock yards in Watertown, the Boston & Albany stock yards in Brighton, or the New England Dressed Beef and Wool Company in Somerville, not accompanied by a permit, as provided in paragraph 2 hereof, you will immediately notify this office, giving the place where said animals were received for shipment, the name of the consignee and destination of said animals. You will not remove said animals or permit them to be removed from the car or vehicle in which they are contained without a permit from this Board or some member thereof; except that if, by reason of the crowded condition of the car or because of the long confinement of said animals within the same, or for accident or otherwise, it is deemed expedient by you or your agent to unload the same, such animal or animals may be removed by you from said car or vehicle without such permit; but in such case you will notify this office, and you will not allow said animal or animals to go out of the possession of your agent or off of your premises where said animals are unloaded, except upon obtaining such permit.

Fourth.—All neat cattle brought within the limits of the premises in Brighton, Watertown and Somerville, designated in paragraph 1 hereof, are hereby declared to be quarantined.

Fifth.—Any person violating the provisions of this order will be punished as provided in section 47 of chapter 491 of the Acts of the year 1894.

This order shall take effect upon the seventeenth day of October, 1898.

AUSTIN PETERS, *Chairman*,
JOHN M. PARKER, *Secretary*,
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,

Board of Cattle Commissioners.

In considering the question of compensation, it is of interest to notice that most countries give some compensation where tuberculous cattle are condemned by the State.

In Massachusetts it has been the custom to refuse compensation when animals die, or are just dying, from this disease; otherwise, within limits, full compensation has been given. It should be noted, however, that the passage of the law relating to the use of flesh of animals slightly infected with tuberculosis changes the conditions somewhat; and, while on this subject, it might be of interest to notice that possibly no recent changes in the laws relating to this matter promise to do more to promote an economical and frictionless working of the law than this one, which was advocated in the last annual report and adopted by the Legislature during the past session.

This modification relating to the use of meat has not been met by any corresponding change in the law relating to compensation. The law might with advantage be altered, so that when an animal is quarantined by the inspector because of physical evidence of tuberculosis, and is condemned by the Cattle Commission, the owner should receive either full or partial compensation. On the other hand, after being quarantined by the inspector, if, in the opinion of the Board, no physical evidence of tuberculosis is present, the animal should be released; then, if the owner is dissatisfied, the animal may be tested, and if found infected it may be killed, the owner to receive the beef value of the carcass.

It would further seem advisable that in case any "request work," or testing of entire herds upon request of the owner,

was done, the owner should have the option of either separating the reacting from the non-reacting, and following out the principles laid down by Bang under direction of the Board, or having the reacting animals killed and appraised, the owner to receive the beef value of the carcass.

Such a method of compensation, when the test is made on the request and in the interest of the owner, would result in no voluntary testing being done unless the owner was in earnest in his desire to have the disease eradicated from his herd. If he had to bear a proportional part of the cost, he would naturally be more careful. Unless an owner is heart and soul in the work, the law is powerless to relieve him. Stock owners should realize that to keep a herd that has once been seriously affected free from disease depends more upon the continual watchfulness and care of the owner than upon any laws the State may enact.

Another practical point that might well be referred to here is that of slaughter-house inspection and the supervision of local slaughter houses. It appears to us as though the supervision of this work more properly belonged to the local boards of health.

The method of licensing a number of small scattered slaughter houses is another point that should be remedied. The system is not one that lends itself readily to either convenience or economy in inspection; and, in fact, from every point of view it would seem to be better to do away with the small private slaughter houses, and give cities and towns power to establish public abattoirs, where those engaged in this business could rent stalls at a fair rate, and where the work of supervising them could be done more satisfactorily and more economically than at the present time.

TEXAS FEVER.

There has been no Texas fever in this Commonwealth during the past summer, but a few remarks upon the steps taken to prevent an outbreak similar to the one reported in 1897, and the benefit to cattle owners resulting from the investigation made by Dr. Cooper Curtice, acting under authority of

the Massachusetts Cattle Commission, as given in full in the last annual report, may not be out of place at this time.

The latter part of May the following letter was written to Dr. William Henry Kelly, veterinarian to the New York State Department of Agriculture, in order to ascertain if any steps were being taken to protect Massachusetts from a similar outbreak to that of the previous year:—

BOSTON, May 28, 1898.

Dr. W. H. KELLY, *Albany, N. Y.*

DEAR SIR:—Has the Bureau of Animal Industry put an inspector on at the Albany stock yards for this summer, and what precaution has been taken to protect Massachusetts against another outbreak of Texas fever, such as we had last year? If you will write and tell me what has been done, or if nothing has been done, it will be a great favor.

Yours truly, AUSTIN PETERS, *Chairman.*

To this Dr. Kelly replied as follows:—

ALBANY, N. Y., June 3, 1898.

Dr. AUSTIN PETERS, *Boston, Mass.*

DEAR SIR:—Yours of the 28th ult. is received. In reply, will state that the Bureau of Animal Industry has not put an inspector at West Albany. I consulted with the Commissioner of Agriculture of this State, and he thinks he will have a veterinarian look after these yards, thereby preventing Massachusetts from having a similar occurrence as that of last year.

He is to let me know by Tuesday of next week what action he is going to take in the matter, and I will inform you.

Yours respectfully, WM. HENRY KELLY.

The following reply was sent to Dr. Kelly, and at the same time a letter was written to the United States Secretary of Agriculture at Washington:—

BOSTON, June 6, 1898.

Dr. WM. H. KELLY, *Albany, N. Y.*

DEAR SIR:—Thank you for your letter of June 3. Our commission will owe the Agricultural Commissioner of your State a debt of gratitude if he has a veterinarian in charge of the yards at Albany this season. At the same time, I think it is the duty of the Bureau of Animal Industry to protect us against Texas fever, and I have written facts in the case to the Secretary of Agriculture at Washington.

Yours truly, AUSTIN PETERS, *Chairman.*

Dr. Kelly replied to the second letter, as below :—

ALBANY, N. Y., June 7, 1898.

Dr. AUSTIN PETERS, *Boston, Mass.*

DEAR DOCTOR :— Yours of the 6th inst. is received. The commissioner has concluded to have a man visit West Albany stock yards each day, and find out what cattle pass through there. This will be done under my personal supervision, and if any question arises, I am directed to investigate immediately. As a rule, I am at West Albany every day, consequently will be on the grounds.

He has also written Dr. Hinkley, United States government inspector, at Buffalo, and asked him to inform him whenever any quarantined cattle are shipped into or through this State; also asked him to give car number and destination, whereby we will see that it does not stop at West Albany.

Any other question you would like to ask in relation to this I will be pleased to answer.

Yours respectfully,

WM. HENRY KELLY.

The United States Secretary of Agriculture was written to, as follows :—

BOSTON, June 6, 1898.

Hon. JAMES WILSON, *Secretary of Agriculture, Washington, D. C.*

SIR :— When our annual report came out I sent a copy to you, and also one to Dr. Salmon, as it gave a report concerning an outbreak of Texas fever which occurred here last summer, owing to the fact that quarantine cattle occupied the same pens at Albany stock yards as New York cattle in transit for Brighton market.

After the outbreak occurred, Dr. Salmon had the Brighton yards quarantined for a time, greatly to the inconvenience of the railroads; besides which, it was a loss to our farmers having cattle die from Texas fever, owing to the fact that there is no proper protection at Albany. I think there should be an inspector of the Bureau of Animal Industry at Albany, to see that the law requiring quarantine cattle to have separate pens and chutes from northern cattle is in force. I have written to Albany, and am informed that nothing has been done about the matter as yet.

Hoping we will be protected this season against any such outbreak as we had last year, I am,

Yours respectfully,

AUSTIN PETERS, *Chairman.*

To which he made the following reply : —

WASHINGTON, D. C., June 15, 1898.

Dr. AUSTIN PETERS, *Chairman, Board of Cattle Commissioners,
Commonwealth Building, Boston, Mass.*

DEAR SIR:—I am in receipt of your letter of the 6th inst., relative to the necessity for stationing an inspector of the Bureau of Animal Industry at Albany, N. Y., to supervise the shipment and isolation of quarantine cattle. The matter will receive immediate attention, and it is probable that an inspector will be stationed at Albany, as recommended by yourself.

Very truly yours, JAMES WILSON, *Secretary.*

An inspector of the United States Bureau of Animal Industry was soon after stationed at the Albany stock yards, to see that the rules and regulations of the Department of Agriculture, requiring cattle from infected districts to be driven through separate chutes and yarded in different pens from northern cattle, were enforced.

This Board is also informed that new stock yards at Albany have been built this autumn by the New York Central Railroad Company.

As the outbreak of 1897 was clearly due to the utter neglect to carry out the rules and regulations of the Bureau of Animal Industry relating to "scheduled" cattle at Albany, by the New York Central Railroad Company, the farmers and drovers who lost cattle from Texas fever at that time were advised to pool together and employ legal counsel in an endeavor to recover the value of the animals that died from this cause. The result of this action has been that the New York Central Railroad Company has settled with the Massachusetts owners of these animals on a basis approximating four-fifths of their value, amounting to about \$1,600. The liability of the railroad company having been thus established, the parties in Connecticut who lost cattle were notified of the fact, and a settlement on the same basis was secured for them, amounting to in the neighborhood of \$350 more.

It is apparent from the foregoing statement that the action of the Massachusetts Cattle Commission in investigating the outbreak of Texas fever in the summer of 1897, as it did,

has resulted in not only better protection to the live stock interests of the State the past season, but also to partial remuneration to our cattle owners for the animals they lost from this disease the year before, as well as to those in a sister State.

Experiments have been carried on by the Bureau of Animal Industry in dipping cattle to destroy the ticks, and thus render it safe to ship cattle from the fever-infected districts into northern States at any season of the year. That is, believing that the disease is carried from infected animals to healthy ones only through the medium of the ticks, it is thought that by dipping the cattle in some preparation that will kill the ticks they can then mingle with northern creatures with safety. If this method proves successful and is extensively adopted, the danger of outbreaks of Texas fever in our northern herds during the summer months will have become a thing of the past. It is too soon, however, to know positively whether this method will prove practicable, or not; meanwhile, enforcing the rules and regulations requiring "quarantine cattle" to be kept apart from northern cattle, driven over separate chutes and yarded in pens set aside for them during the portion of the year when there are no killing frosts, will serve to prevent outbreaks of this disorder, although it does not allow of as free a traffic in cattle as can exist if dipping proves to be a success.

GLANDERS.

Since issuing the last report glanders has continued to be quite prevalent, although there has been a falling off in the number of cases reported to the Board of Cattle Commissioners from that of 1897.

From Dec. 15, 1897, to Dec. 15, 1898, 428 horses have been reported to the Board as having glanders and farcy, or suspected of having glanders or farcy. Included in this number are 2 which had not been disposed of at the time of making the last report. One of these was released from quarantine as free from disease; the other was taken out of quarantine by its owner, who departed with his property to Connecticut, contrary to law, — his exact destination was

never ascertained. This makes 426 new cases, the other 2 included in this year's work making the total of 428. Of this number, 41 have been released from quarantine as being free from disease, 386 have been killed as being infected with either glanders or farcy, and 1, which probably had glanders, was illegally removed by the owner.

The following table gives the number of cases reported from each city and town, and shows the result of the examination:—

	Condemned.	Released.	Totals.		Condemned.	Released.	Totals.
Acushnet, . . .	1	-	1	Marblehead, . .	2	-	2
Arlington, . . .	1	-	1	Marlborough, . .	1	-	1
Auburn, . . .	1	-	1	Medford, . . .	2	1	3
Belmont, . . .	1	-	1	Melrose, . . .	1	-	1
Beverly, . . .	1	-	1	Merrimac, . . .	-	1	1
Boston, . . .	137	1	138	Middleborough, . .	1	-	1
Boxborough, . .	1	-	1	Millbury, . . .	-	1	1
Brockton, . . .	3	1	4	Milford, . . .	1	1	2
Brookline, . . .	2	-	2	Monson, . . .	1	1	2
Cambridge, . . .	25	3	28	Montague, . . .	1	-	1
Carlisle, . . .	1	1	2	New Bedford, . . .	10	-	10
Charlton, . . .	1	-	1	Newton, . . .	4	-	4
Chelmsford, . . .	2	-	2	North Reading, . .	1	-	1
Chelsea, . . .	9	1	10	Plympton, . . .	1	-	1
Chicopee, . . .	2	-	2	Quincy, . . .	2	1	3
Clinton, . . .	12	1	13	Reading, . . .	5	-	5
Conway, . . .	-	1	1	Revere, . . .	5	-	5
Danvers, . . .	1	-	1	Salem, . . .	-	1	1
Dennis, . . .	1	-	1	Saugus, . . .	-	1	1
Fall River, . . .	16	4	20	Sherborn, . . .	1	-	1
Fitchburg, . . .	7	2	9	Somerville, . . .	36	4	40
Granville, . . .	-	1	1	Spencer, . . .	-	1	1
Hamilton, . . .	1	-	1	Springfield, . . .	6	1	7
Hatfield, . . .	1	-	1	Sutton, . . .	2	-	2
Haverhill, . . .	3	-	3	Swampscott, . . .	1	-	1
Hingham, . . .	2	-	2	Waltham, . . .	8	-	8
Holyoke, . . .	1	-	1	Watertown, . . .	3	-	3
Hull, . . .	1	-	1	Webster, . . .	1	-	1
Hyde Park, . . .	1	-	1	Wellesley, . . .	2	-	2
Lancaster, . . .	2	-	2	Westfield,* . . .	1	-	1
Lawrence, . . .	1	-	1	Westport, . . .	1	-	1
Leominster, . . .	1	1	2	Winthrop, . . .	5	-	5
Leverett, . . .	-	1	1	Woburn, . . .	1	-	1
Lexington, . . .	-	1	1	Worcester, . . .	25	4	29
Lynn, . . .	6	2	8				
Lynnfield, . . .	1	-	1	Totals, . . .	387	41	428
Malden, . . .	10	2	12				

* Run off by owner, probably had glanders.

As compared with the number of cases reported in 1897, the above table shows a decrease not only in the number of animals but also in the number of cities and towns from which cases were reported the previous year.

In 1897 there were 402 horses killed as being affected with this disease, — 16 (not counting the horse run off) more than during 1898. Eighty-one were reported as diseased which were released as free from glanders or farcy, — 40 more than in 1898; the total number in 1897 of real or suspected cases exceeded those of 1898 by 61, crediting the 2 cases not disposed of at the close of 1897 to that year.

In 1897 cases or suspected cases of glanders or farcy were reported from 83 cities and towns, while in 1898 but 71 cities and towns reported cases of this disease, — a falling off of 12.

One of the cases reported from Lynn was quarantined and released in the latter part of 1897, and requarantined by the inspector in the spring of 1898, as the symptoms had developed further, and it was ordered killed as having glanders.

One of the cases reported from Fall River is entered twice, as the horse was quarantined as having farcy and its release ordered by the Board; later, further symptoms made their appearance, and the owner had the inspector kill the horse, which was then reported as killed for farcy with the owner's consent; therefore, in reality the total number of cases reported from Fall River is 19 instead of 20.

As in previous years, Boston leads in the number of cases; but it must be borne in mind that Boston is much larger than any other city in the State, and is also the centre for a vast amount of traffic, requiring a great number of horses. In fact, more than half the number of cases reported have been within ten miles of the State House, 138 in Boston, 28 in Cambridge, 40 in Somerville and 10 in Chelsea, making a total of 216.

Boston and Cambridge had about the same number of cases the past year as in 1897, while Somerville and Chelsea show an increase. Four of the cases reported from Waltham should really be credited to Boston. The horses belonged to an express company in Waltham, but had been boarded at a stable in Boston; for some reason they were brought

home, and two of them were found to be diseased with farcy the day after they arrived in Waltham, and were immediately killed; another developed symptoms of farcy a few days after he was brought home, and was killed within a week or ten days of the time of his removal from the stable in Boston; the fourth horse also had farcy, and was killed about the same time as the others, but had been brought from the boarding stable to the home stable in Waltham a few weeks earlier than the other three. There was no history of any glanders or farcy in the express company's stable in Waltham prior to bringing these four horses home, but a number of cases killed as glandered have been reported to the Board of Cattle Commissioners by the inspector of Boston, as coming from the boarding stable where the express company's four horses were kept.

Another instance of the manner in which the disease may be disseminated from a large centre of infection, as that existing in Boston, may be illustrated by the case at Plympton, or one of the cases at Lancaster.

The horse at Plympton was at the ice houses at Silver Lake; he was brought there from Dorchester last winter by the ice company. After deciding that the animal had glanders, the Boston inspector was notified and went to the ice company's stable in Dorchester and found two more horses with glanders, which he ordered killed. The horse at Plympton had been kept by himself from winter until August, when the case was reported to the Board and the horse ordered killed. Another example is a case at Lancaster. A farmer bought a cheap horse at a well-known sale stable in Boston, to help do the extra work of the summer months; he was reported as having glanders after the farmer had owned him a couple of months, and was ordered killed. As he was a slow horse for farm work, he was not taken off the farm during his stay there, and, as far as the Board is informed, none of his owner's other horses became infected. The horse at Plympton was also kept alone, and only worked around the premises of the ice company. Fortunately, these two cases appear to have done no damage by contaminating other animals.

The most gratifying results have been those obtained in

Worcester, where in 1896 there were 100 cases of suspected glanders and farcy reported to the Cattle Commissioners ; in 1897 it was reduced to 84 and in 1898 to 29. This has been accomplished in part by closing the public watering troughs for awhile in 1897, and by keeping up a constant supervision of sale stables and auction rooms, as well as keeping all other suspicious localities under careful observation.

The Board is of the opinion that the cases of glanders and farcy have been pretty generally reported to it during 1898 ; and, while many horses are quietly killed by the owners and not reported for fear of hurting the reputation of their stables, and while a few unscrupulous individuals are not above selling or trading off a glandered horse, yet in the main a larger proportion of the cases have been reported than in previous years ; and as a rule there is a tendency among local authorities and veterinarians to co-operate with the Board of Cattle Commissioners in their endeavors to lessen the ravages of this dangerous disease. It is to be hoped that another year will show a still further decrease from 1898 in the number of cases of this malady.

As in 1896 and 1897, doubtful cases have been held in quarantine until guinea-pigs could be tested with the nasal discharge or with material from farcy sores, in order to establish a correct diagnosis, and this proves a very satisfactory method as a rule ; occasionally it is necessary to obtain material a second time, but generally the first test is sufficient. Mallein has been satisfactorily used a few times, but usually the guinea-pig test seems preferable. Of course in perfectly clear, well-marked cases it is not necessary to verify the diagnosis.

The work of establishing the correctness of the diagnosis by means of the guinea-pig test has been done in part by Dr. Langdon Frothingham and a portion by Dr. Theobald Smith. The tests made by Dr. Smith have been done free of charge, owing to the crippled condition of the finances of the Board, caused by the failure of the last Legislature to make a sufficient appropriation. The Board of Cattle Commissioners take this opportunity to express their deep obligations to Dr. Smith for all his courtesy.

RABIES.

At the time of compiling the last report, in December, 1897, it was said that rabies among dogs was commencing to decrease in prevalence, and it was hoped that it was becoming less frequent, and in time would die out until another outbreak occurred. Unfortunately, this has not been the case. Early in the year of 1898, reports of rabies began to come in from Lynn, Swampscott and Salem, and later cases from other localities in the eastern part of the State have been called to the attention of the Board at various intervals up to the present time.

There were 35 cases of rabies or suspected rabies investigated by the Board of Cattle Commissioners during the year, including 32 dogs, 1 horse, 1 cat and 1 rat. Of this number, 18 animals have been proved to have been rabid by inoculating rabbits, including the horse and the cat.

Four animals sent in as suspected of being rabid have proved not to have been so by the rabbit test, including the rat. The head of one dog was too far decomposed when it arrived to be of any use for diagnostic purposes; another dog is known to have been rabid, as two dogs supposed to have been bitten by him afterward became rabid and were proved so by the rabbit test; 9 dogs have been reported as rabid by local inspectors, where the diagnosis has not been verified; and 2 quarantined by the local inspector were found not to be suffering from hydrophobia.

In addition, 33 dogs have been quarantined by order of the Board of Cattle Commissioners or by the local inspectors, because of their having been bitten, or having been where they might have been bitten, by rabid dogs. In these cases the quarantines are continued for ninety days, at the expiration of which time the animals are released if they appear to be healthy.

Of the 33 dogs thus quarantined, 2 have died of rabies; 3 or 4 have been killed by their owners, for fear they might become rabid; the rest have been released at the expiration of the period of quarantine, with the exception of 11 which were quarantined about the 1st of October, and whose

ninety-day period of enforced seclusion will not be over until the last of the year.

More drastic measures for the suppression of rabies would be to shoot all dogs known to have been bitten by rabid animals; but public opinion would not support such extreme measures, and a ninety-day quarantine of all dogs bitten, or that may have been bitten, is a great safeguard, although not an absolute protection, as in some cases the latent period is longer than this, and in rare instances is supposed to be capable of covering several months or even a year.

Muzzling all dogs running at large for two or three months, in localities where there is an outbreak of rabies, is also a protection, if properly carried out; all dogs running at large, without muzzles, to be caught and impounded, and, if not claimed by their owners within a reasonable length of time, to be killed. This method was resorted to in Swampscott and Lynn last spring. Owing to the many reports of cases of rabies coming from these two places, and Salem, early in April, the chairman and secretary of the Board visited these three towns, with the result, after conferring with the health authorities, that the boards of health of Lynn and Swampscott ordered all dogs running at large upon the streets to be muzzled until the 15th of June. The consequence was that no more reports of cases of rabies came from these localities until after the expiration of the muzzling order, when the last of June another case was reported in Lynn in a dog that came from Swampscott. Since then, however, but two more cases have been reported from Lynn and none from Swampscott and Salem, neither of which have proved to be rabies as yet by the rabbit test.

Another important measure for the suppression of rabies is a thorough enforcement of the license law, as it is the homeless, neglected mongrel or cur that is most likely to disseminate this malady. Any one who cares enough for a dog or is responsible enough to pay a license fee will probably keep it under observation to a certain extent; and, if the animal is noticed to be ailing or acting strangely, it may be secured, so that the danger of its doing damage is less than that of the homeless, ownerless dog, who may run

a-muck before anything wrong is noticed about it. It is, therefore, very important that the police of all cities and towns see that the dog license law is very rigidly enforced every spring. If it were not for the fact that the majority of cases of hydrophobia are what is known as "dumb rabies," the disease would prevail more extensively than it does. Probably nine out of ten cases assume this form, and it is only 10 per cent. or thereabouts that have what is known as "furious rabies," with a disposition to run away from home, biting persons, dogs or other animals with which they may come in contact.

These two forms of rabies, "dumb" and "furious," are in reality one and the same disease. Whether the dog mopes around home and finally becomes paralyzed and dies, or runs off and does a lot of damage before dying, depends upon the conditions surrounding the animal at the time the disease develops, and in part upon its natural disposition. If anything occurs to unduly excite its mental activity or make it nervous at the time the trouble develops, the "furious" form may ensue; if it is quiet around the house or barn and nothing transpires to worry or excite it as the symptoms are about to appear, the "dumb" form will probably develop, and the animal will die quietly at home without doing any harm. The latter is the case usually, hence the reason for hydrophobia not being more frequent than it is.

At the same time, when it is considered how frequently the disease occurs, and the great amount of damage done by mad dogs in biting other animals and persons, as well as the danger of fatal results to human beings from wounds inflicted by the teeth of such canines, the matter becomes one of very grave importance, and all reasonable steps for the suppression of the disease should be resorted to.

The protective inoculation of Pasteur for the prevention of rabies practically does away with the danger from the bite of a rabid dog; at the same time, the nervous worry and expense incident to a trip to New York to undergo treatment at the Pasteur Institute is a serious matter, especially in many cases where the persons bitten can ill afford the cost. The question naturally arises, whether it would not be well to equip a laboratory to furnish the necessary preventive

treatment by the State, if rabies is to continue to be as prevalent as it has been the past two or three years.

If the State is to furnish the means for producing diphtheria antitoxin and tetanus antitoxin, there are just as good reasons for furnishing the Pasteur protective inoculation to patients; as it is rather too expensive a process to be carried on by a private laboratory, and it is a great hardship and expense for persons of limited means to go a long distance for treatment, as has been the case with many of those bitten during the past year or two.

Of course only a small per cent., probably but twelve to fifteen per cent., of all the persons bitten by rabid dogs develop rabies. If the animal bites through clothing, or has previously bitten several articles, the virus may be wiped off the teeth so that none is introduced into the wounds it inflicts, in which case no evil results ensue, but bites upon the bare hands or face of persons attacked are to be looked upon as very dangerous. In rare instances patients have developed rabies when undergoing, or soon after finishing, the Pasteur treatment; but these cases have followed bad bites upon the bare arms or face, or too much delay before commencing the treatment.

In cases of supposed rabies in dogs the police authorities frequently adopt anything but a wise course in shooting the animal, and calling it mad without positively knowing whether it is or not. In these instances, especially if any persons are bitten, the dog should be secured at once if possible, and safely chained or shut up where he can be observed for awhile. If laboring under some other form of mental excitement than rabies, it will probably recover in time; if it becomes worse, so as to have to be killed, it should be chloroformed, and the head sent at once to the laboratory while fresh, to inoculate rabbits. Shooting is objectionable from a scientific point of view, as it injures the brain and introduces septic organisms that interfere with the test on the rabbits. If after shooting the dog is buried for two or three days, and then dug up as an after thought to ascertain whether it was rabid or not, decomposition of the brain will be still farther advanced, and may be so much so as to render it valueless to determine correctly

whether the trouble was rabies or not. If the dog dies of himself, the head should be at once removed and immediately sent to the laboratory, if it is necessary to make a diagnosis. Owing to the expense of making the test, it is not generally advisable to undertake it unless the supposed rabid animal has bitten other dogs or persons.

If persons have been bitten, it is very important to establish a correct diagnosis, in order to decide whether it is best for those injured to undergo the protective treatment or not. As a rule, a rabbit inoculated will develop rabies in a sufficiently short space of time to give the person ample opportunity to go to the Pasteur Institute; while, if the result is negative with the rabbit, the person bitten may rest assured that he was not injured by a rabid animal, and is, therefore, in no danger of contracting rabies. When a dog's head arrives at the laboratory with the brain torn by bullets, or after decomposition has set in, it delays the result in making a diagnosis, or even prevents it being made altogether, hence the importance of its being fresh and intact.

The appended table gives the cases reported to the Board of Cattle Commissioners during the past year, showing the month, town, species of animal and damage done, as far as known. It is hoped that the efforts of the Board for the suppression of this dangerous scourge will meet with such success that in time it may again disappear; but to do this the hearty co-operation of local boards of health and police authorities in all cities and towns is necessary.

MONTH.	Town.	Species of Animal.	Result of Rabbit Test.	Remarks.
January,	Braintree,	Dog,	Positive (Dr. Frothingham).	
January,	Lynn,	Dog,	Positive (Dr. Frothingham).	
January,	Lynn,	Dog,	Positive (Dr. Frothingham),	Blt a man, a boy and five dogs.
January,	Salem,	Dog,	Positive (at Pasteur Institute, New York).	Blt a man, who went to Pasteur Institute; and a mare, that died of rabies. Four dogs were quarantined by local inspector for ninety days, but none of them have ever developed rabies, and may not have been bitten.
January,	Swampscott,	Dog,	No test made,	Shot as supposed case of rabies.
January,	Melrose,	Dog,	Positive (Dr. Frothingham).	Killed as supposed case of rabies.
January,	Lynn,	Dog,	No test made,	Bitten by a dog, as given above.
January,	Salem,	Mare,	Positive (Dr. Frothingham),	Reported to have bitten owner and several dogs.
February,	Lynn,	Dog,	Positive (Dr. Frothingham),	Killed by order of board of health.
February,	Salem,	Dog,	No test made,	Head when it arrived too decomposed to use.
February,	Danvers,	Dog,	No test made,	Killed as rabid by dog officer.
February,	Lynn,	Dog,	No test made,	Killed as rabid by dog officer.
February,	Lynn,	Dog,	No test made,	Came from Ocean Street, Lynn. One dog bitten by him shot, eleven other dogs near by quarantined ninety days, then released.
March,	Swampscott,	Dog,	Positive (Dr. Frothingham),	Killed as rabid by dog officer.
March,	Lynn,	Dog,	No test made,	
March,	Lynn,	Dog,	Positive (Dr. Frothingham).	
March,	Lynn,	Dog,	Positive (Dr. Frothingham).	
March,	Lynn,	Dog,	Negative (Dr. Frothingham),	Killed as supposed rabies by dog officer.

MONTH.	Town.	Species of Animal.	Result of Rabbit Test.	Remarks.
April, .	Watertown, .	Dog, .	Positive (Dr. Frothingham), .	Killed by policeman after biting a child.
April, .	Haverhill, .	Dog, .	Negative (Dr. Frothingham), .	Killed by member of board of health.
June, .	Lynn, .	Dog, .	Positive (Dr. W. F. Whitney, for Lynn Board of Health), .	Came from Swampscott. Reported to have bitten several people and dogs. Two dogs quarantined for ninety days were released, having shown no symptoms of rabies.
July, .	Lynn, .	Dog, .	-	Killed by order of the board of health.
September, .	Lynn, .	Dog, .	-	Quarantined by inspector as tuberculous, probably chronic bronchitis.
September, .	Lynn, .	Dog, .	-	Was not a case of rabies, but viciousness. Killed by consent of owner.
September, .	Boston, .	Dog, .	-	Killed as case of rabies by inspector of animals.
September, .	Newton, .	Dog, .	-	Reported as rabid. Bit three people and several dogs. Twelve dogs in the neighbor- hood were quarantined, two have since been killed by their owners to avoid dan- ger, and two have died with rabies. Fight are still in quarantine.
October, .	Newton, .	Dog, .	Positive (Dr. W. F. Whitney, for Newton Board of Health), .	Bitten by dog, as reported above.
October, .	Newton, .	Dog, .	Positive (Dr. Frothingham), .	Bitten by dog, as reported above.
October, .	Lynn, .	Dog, .	Negative (Dr. Frothingham), .	Bit several people and dogs. Three dogs still in quarantine as a matter of pre- caution.
October, .	Quincy, .	Cat, .	Positive (Dr. Frothingham), .	Bit two or three persons.
October, .	Boston, .	Dog, .	Positive (Dr. Frothingham), .	Bit a woman.
October, .	Boston, .	Brown rat, .	Negative (Dr. Frothingham), .	Bit a man; injury slight.
October, .	Dracut, .	Dog, .	Positive (Dr. Frothingham), .	Reported as case of rabies by inspector of animals.
November, .	Lowell, .	Dog, .	Positive (Dr. Frothingham), .	
December, .	Boston, .	Dog, .	-	

DISEASES OF SWINE.

During 1898 a few outbreaks of hog cholera or swine plague have been reported to the Cattle Commission, probably more or less confusion of the application of the two terms existing. There were seven outbreaks reported in all: one at Framingham, in January; four in February, at Framingham, Foxborough, Westport and Worcester; one in September, at Hyannis; and one outbreak in December, at Lanesborough, upon three different farms. Where disease appears among a herd of swine, about all that can be done is to forbid the owner to buy or sell any pigs until the trouble is over. If any are fit for market, they may be killed, subject to the usual meat inspection. When the outbreak is over, the premises must be thoroughly disinfected; and, if traceable to the food in any way, the swill should either be thoroughly boiled before feeding it to pigs, or an entire change of food may be made. Occasionally, where city swill is fed and swine plague is suspected, which is simply a septic infection, boiling will destroy the germs and check the disease; in other cases the sickness may be due to some ptomaine in the swill or some other poison, or even large quantities of soap used in dish water. In these cases boiling does not serve to destroy the poison.

Of the reported outbreaks, those early in the year were managed as suggested above,—that is, killing marketable hogs, subject to the examination of the inspector of provisions, and forbidding buying or selling pigs from the infected premises until the disease disappeared and the buildings and pens were disinfected.

The case of swine disease at Hyannis in September was investigated by a member of the Board, who reported that the herd of pigs belonged to a hotel; several had been sick, two had died and the others were recovering. There was no chance to hold an autopsy. The pigs were running at large in a field, and were fed upon hotel swill. The trouble may have been caused by soap in the swill; it did not seem to be hog cholera. It was advised to stop feeding the animals upon the swill from the hotel.

The outbreak at Lanesborough has just been reported, and is at present being investigated.

The Department of Agriculture at Washington is now experimenting with a serum treatment for the prevention or cure of hog cholera and swine plague. If a serum or antitoxin for these diseases can be produced, so that the Board can assist farmers to protect their swine by protective inoculation, or by treating well and diseased in these outbreaks, it is not unlikely that more cases of disease among swine would be reported to the Board than at present.

Swine frequently have tuberculosis ; but as a general thing the first notification received by the Board of this disease among pigs, is that animals have been condemned by the inspectors at the time of slaughter because infected with this disorder to such an extent as to render them unfit for human food.

OTHER CONTAGIOUS DISEASES.

There have been no reports of other suspected contagious diseases of animals during the past year, with the exception of a disease among cattle at Marston's Mills, in the town of Mashpee, thought to be anthrax. The secretary of the Board investigated the matter at the time he investigated the outbreak of swine disease at Hyannis in September, but failed to find the cows suffering from any communicable disease.

AUSTIN PETERS, *Chairman.*

JOHN M. PARKER, *Secretary.*

MAURICE O'CONNELL.

LEANDER F. HERRICK.

CHARLES A. DENNEN.

APPENDIX.

FOREIGN COUNTRIES.

GERMANY.

In Germany, sanitary measures, more especially in regard to meat inspection, are very thoroughly carried out.

In Bavaria, owing to the losses sustained by cattle owners by the spread of tuberculosis the government, proposes to manufacture and supply tuberculin to veterinary surgeons at cost price. After testing, the healthy animals should be separated from the others, the diseased animals gradually got rid of, and the cow sheds occupied by them disinfected. The result of the test must be forwarded to the government.

A repetition of the test must not be undertaken except after a lapse of from fourteen to twenty days. Results are classified as follows:—

1. Animals that have not reacted, and do not show any other sign of disease, shall be isolated from the suspected animals.
2. Animals which have given a doubtful reaction, or which show, in spite of their yielding negative results to the test, signs of tuberculosis, are to be regarded as being suspected of tuberculosis, and it is recommended that they be further watched and subjected to a later test.
3. Animals that have shown a decided reaction. These last can be further subdivided into (a) those presenting no other symptoms of disease except reaction (b) those having in addition clinical symptoms.

The latter are undoubtedly the most dangerous portion of the stock, and are the chief source of danger in the further spread of the disease.

It is highly desirable, therefore, for the owner to separate them at once from the other animals, and get rid of them as soon as possible.

To reject the animals falling under (a), which are in a good state of nutrition, is impracticable, especially on large farms, and unnecessary. Efforts must be made, therefore, to rear them and

to keep their calves; the latter should be separated the second day from birth, and fed only on well-boiled milk.

The meat may be sold if the tuberculous process is localized or in the first stages of development, and the body in good state of nutrition. If the disease is generalized or in the substance of the flesh, the carcass is destroyed. Killing is all done in public slaughter houses under careful inspection.

In Saxony, so far as the State is concerned, tuberculin inoculations are only employed in the case of animals to be used for stock-raising purposes, and belonging to societies supported by the State; animals that react must not be used for breeding. The use of tuberculin in other cases is a private matter, but the State arranges so that tuberculin can be obtained at cost price.

In the case of meat inspection, the regulations are much the same as in Bavaria and Prussia.

FRANCE.

Cattle coming into France are placed under observation on the frontier at the expense of the importers for forty-eight hours at least, and are submitted to the tuberculin test. Under the law of 1881, every owner or person who has charge of an animal that is affected, or is suspected of being affected, with cattle plague, pleuro-pneumonia contagiosa, sheep-pox and itch, foot-and-mouth disease, glanders and farcy, hydrophobia and anthrax (and by an order of July, 1888, symptomatic anthrax and tuberculosis), must immediately declare the fact to the mayor of the commune; the animals must be isolated and must not be removed until the veterinary surgeon appointed by the administration has examined them.

Under date of September, 1896, the order relating to carcasses of tuberculous animals was put in force. It is the same in principle as in Germany.

BELGIUM.

In Belgium they believe that it is not practicable to group tuberculosis with other contagious diseases.

The law gives the minister of agriculture power to forbid the entrance of animals coming from countries where tuberculosis is known to exist, or he may cause them to be tested at the importer's expense.

In Belgium tuberculin can *only* be used under authorization from the minister of agriculture, and all tests must be communicated to the government. Veterinary surgeons must notify the district inspector if they find or suspect a case of tuberculosis by clinical

examination. In such a case the owner may request the use of tuberculin. When the diagnosis is confirmed, the animal must be slaughtered within a week.

Any cattle owner on application is allowed to have his herd tested with tuberculin, and, *except to the meat market*, he must not sell any animals that react. The test in such a case is made at the owner's expense; but when the test is made because of the discovery of the disease in the living animal, it is done at the expense of the government.

After a herd has been tested, the reacting animals must be kept separate, and the owner must disinfect the premises previously occupied by the animals to the inspector's satisfaction.

The owner conforming to these conditions can continue to make use of reacting animals, provided he allows periodical testing when necessary, takes care of infection, removes calves soon after birth, and tests animals introduced into the herd.

Animals that have reacted to tuberculin, so long as they show no clinical evidence of disease, are not subjected to any time limit within which they must be slaughtered.

No compensation is given where regulations are not adhered to, nor where the cow shed is in a notoriously unsanitary condition. No compensation is given in case of animals dying of tuberculosis, nor in case of animals in last stages of the disease.

Compensation is given up to 50 per cent. of the value of the flesh and organs, in the case of animals recognized as tuberculous at the time of slaughter for the meat market, when the carcass is totally condemned. In the case of animals slaughtered by order of authority as clinically affected or suspected, and having reacted to tuberculin:—

(a) For cattle ordinarily employed for breeding, 70 per cent. of the value, if the flesh is totally condemned for food; and 25 per cent. of same value, if declared fit for food, with smaller limit.

(b) Other cattle: 50 per cent. of value of flesh and organs, when totally condemned; 25 per cent. of value, if declared fit for food. In case of animals slaughtered at the request of the owner, *i. e.*, animals which have reacted to tuberculin: for cattle used for breeding, 70 per cent. of value of flesh and organs, when totally unfit for food; 15 per cent., if fit for food.

The main point wherein the present regulations differ from those which have been in force since January, 1896, is that active proceedings are to be taken in the future only in animals showing clinical symptoms of disease.

The regulations regarding the use of meat are practically the

same as in Germany and France; that is to say, the meat can be used as food when the disease is slight, when there are not changes in the muscles or widespread lesions in the viscera.

DENMARK.

Tuberculin will be provided to owners who guarantee to keep reacting animals separate. The owner must not conduct animals infected with manifest tuberculosis to fairs, cattle shows, pasture lands or strange stables, nor sell the animal so diseased except for the meat market. He cannot sell the meat until inspected and passed as fit for human consumption. Neither shall he sell the milk of cattle affected with *tubercle of the udder*, or use it for food of man or the manufacture of butter or cheese, nor use it, except when boiled, for feeding other animals.

SWITZERLAND.

In Switzerland the agricultural department supplies tuberculin to such cantons as require it and pay half the expenses connected with the inoculation.

The test must be applied to every animal over six months old in the herd of the person applying for it.

Animals that react must be marked by having a small triangular portion punched out of the right ear. Those that do not react and show no other evidence of tuberculosis must wear some distinctive mark.

At present no further measure than that of marking them has been proposed in the case of suspected animals, owing to the fact that the test does not give any evidence as to the extent of the disease. The owner, however, is recommended to isolate them, and render the milk harmless by boiling.

NORWAY.

In Norway an owner must notify the authorities whenever he is aware of the existence of disease in his herd. They in turn make examinations and report. It is probable that soon all cattle coming from Sweden to the markets at Fredrickshald and Christiana will have to be tested; those that react will be sold for immediate slaughter.

An owner may petition the government for tuberculin and examination of his herd at government expense. In such case, after the test he must separate reacting animals from the others, and disinfect. Those suffering from advanced tuberculosis or tuber-

culosis of the udder, or an emaciated state, must be slaughtered as soon as possible.

New-born calves must be kept away from reacting animals, and newly bought animals must be tested.

CANADA.

Canada has a strict quarantine against all countries, and all cattle entering Canada must be subjected to the tuberculin test. On application from the owner, the government provides veterinary services and tuberculin free.

Quebec. — In the Province of Quebec, the provincial board of health has power to frame regulations for each municipality relating to their milk supply; the present regulations apply principally to the sanitary condition of barns and stables.

Ontario. — In Ontario, power is given the municipal authority to establish public slaughter houses and to examine barns or byres where cows are kept; every cow may be tested and dealt with according to the rules and regulations of the provincial board of health; that is to say, if tested, the animals reacting and showing physical evidence of disease should be dried and fatted for beef as speedily as possible.

Manitoba. — In the city of Winnipeg, the only city of any size in Manitoba, the regulations dealing with this subject are very strict; they provide for the licensing and inspection of dairies, and they provide for the inspection of both the barns and the cattle. The inspector is given power to use tuberculin, and no milk from any cow reacting to tuberculin is allowed in the market.

In Canada the percentage of disease is probably slight. By the order of the chief inspector a few years ago care was taken to notice the evidence of tuberculosis in the organs of animals slaughtered in slaughter houses. The percentage of tuberculosis in lungs examined at Quebec, Halifax and St. John was 2, $2\frac{1}{2}$ and 2 per cent. respectively.

AUSTRALIA.

Victoria. — In Victoria there is only a small percentage of tuberculosis, and, through the constant supervision of inspectors, it is steadily decreasing. As far back as 1883 the government appointed a board of experts to advise on this matter, and to inquire into the existence and extent of tuberculosis in the colony, and what preventive measures should be adopted.

The recommendations of that board have largely been carried out. Tuberculosis is included in the list of contagious diseases.

Municipalities have power to establish public abattoirs; carcasses showing advanced or generalized tuberculosis are condemned.

Tuberculin is being used extensively, the board of public health supplies it free of cost, and in outlying districts it is proposed that the inspectors of stock should apply the test for dairymen and farmers. All cattle entering the colony must be inspected before going into the interior.

Somewhat similar laws are in force in Southern and Western Australia, as well as in Tasmania and New Zealand.

UNITED STATES.

In the United States a strict quarantine is in force against all outside territory, and no bovine is allowed to enter the country without being first tested with tuberculin and passing the test to the satisfaction of the Bureau of Animal Industry.

The quarantine law adopted by many of the individual States is for the purpose of controlling the movements of infected cattle within the country.

MAINE.

Maine was the first of the New England States to adopt the system of placing quarantines on the admission of out-of-State cattle. The law was first enforced in 1892 against Massachusetts, because of the large per cent. of Massachusetts cattle that were found diseased. Later it was placed on all out-of-State territory, except to such as were provided with certificates of tuberculin test. The authorities in Maine test herds only on the voluntary application of the owner, the owner to receive one-half the value, as determined on the basis of health before infection, the limit of compensation being \$100 for pedigreed animals and \$50 for others. The commission have power to investigate as to the existence of disease, and to condemn and destroy such as show physical evidence of disease. During the year 415 head of cattle were destroyed at an *appraisal of \$18,122.*

VERMONT.

Vermont, with its small percentage of diseased animals, has probably been more successful than any other State in its attempts to control tuberculosis. Since Feb. 1, 1897, 60,000 cattle have been tested and 2,390 have been found diseased and killed, — a percentage of disease of nearly 4 per cent. In Vermont no animals are tested unless the owner allows the entire herd to be tested, and thereafter every animal admitted to the

herd must be tested and the stables thoroughly disinfected. The commission test only where application is made by the owner. In their annual report a list of 78 retested herds is given, in which tuberculous animals were found; 23 herds were found free on the second test and 23 had only one case each on the second test; eight of the remaining herds that were found diseased on the second test were free on the third test. The report states that "The proper disinfection is a more difficult matter than is the discovery of the diseased animal."

In Vermont one-half compensation, with limit of \$40, is given for cattle condemned, and all cattle coming into the State must be tested. The commissioners "have found that cattle buyers from States where no quarantine was in force have purchased many suspected animals at a price a little less than would have been paid if not suspected." The law in Vermont has been found to work well.

NEW HAMPSHIRE.

In 1892 New Hampshire had a quarantine against all Massachusetts cattle, except to those showing certificate of soundness based on physical examination; but as a result of the action of other New England States in quarantining against all outside territory, diseased cattle debarred from other States were being introduced into New Hampshire; for this reason a quarantine was placed on all outside territory, and all animals entering New Hampshire had to be tuberculin tested.

Diseased animals are reported to the commission through the selectmen, and are released or condemned on physical examination.

When the owner applies for inspection of his herd, and where there is reason to believe the disease exists, the Board may test the entire herd, the owner receiving half compensation.

CONNECTICUT.

The present law provides that persons bringing cattle into the State shall notify the commission within six days, giving a statement of their physical condition.

The commission has power to quarantine animals showing physical evidence of disease only. They also have power to examine animals by physical examination at the request of the owner. Such animals as are condemned are appraised and killed, the owner receiving full value.

The selectmen must report diseased animals to the commissioner.

RHODE ISLAND.

Rhode Island has a commissioner in each county appointed by the Board of Agriculture, whose duty it shall be to inquire into the condition of any animal in their county whenever there is any reason to suspect tuberculosis. When an animal is thought to be tuberculous by a commissioner he shall immediately quarantine, and the State veterinarian will test the animal to determine the existence of tuberculosis. Owners of animals condemned for tuberculosis shall receive one-half compensation, at the rate of not more than \$50 for native, \$75 for grades and \$100 for registered cattle.

The law specially provides that all cattle going into the State must be certified to be free from disease by physical examination and tuberculin test. A bill was introduced last session of the General Assembly to repeal this law. Hearings were held before a legislative committee, but it has not yet reported.

NEW YORK.

In New York State tuberculosis in cattle is handled by a tuberculosis committee of the State Board of Health. No appropriation has been made by the Legislature for the use of this committee, and no cattle have been ordered killed except where the owners have waived all right to compensation. The committee, however, have received many requests from owners, asking to have their herds tested.

In referring to the destruction of tuberculous animals, the report states:—

It has been generally recognized that the State should in some measure at least compensate owners for cattle destroyed, since, under such conditions as now exist, the fault is not usually with the cattle owner, and the gain in the suppression of tuberculosis is shared by all alike. It would also seem just that the cost of ridding a herd of tuberculosis should be borne by the State only once, but that thereafter the owner should keep it free by admitting no animals without the proof of soundness which the tuberculin test affords. . . . It is the purpose of the State Board of Health of New York to urge upon the Legislature such revision of the existing law upon this subject as shall insure certainty in the detection of the disease, free of cost to the owners of the cattle, and such an appropriation as will secure for the owner a direct and speedy payment by the State for all cattle destroyed, at a fair and equitable rate.

New York State is also complaining that there is no protection there against cattle that are rejected by other States on account

of reacting to the tuberculin test, and are freely sold in New York State to increase the already high percentage of disease in the State.

NEW JERSEY.

New Jersey has a commission of seven members. The commission, on application from the owner, the State Board of Health or the State Dairy Commission, will make an examination of suspected herds, the reacting animals to be condemned and killed. They are appraised at their market value, not exceeding \$40, the owner receiving compensation at the rate of three-fourths of their valuation.

During 1897, 865 animals were tested and 134 were condemned, for which an average payment, at the rate of three-fourths their value, of about \$24.62, was made.

PENNSYLVANIA.

In Pennsylvania the control of contagious diseases among domestic animals is carried on by a State Live Stock Sanitary Board, and, as in Massachusetts, a quarantine is enforced against all outside territory. No cattle are admitted without first submitting to the tuberculin test, the only exception being in the case of animals intended solely for breeding purposes, and these must be kept strictly in quarantine.

It has been the practice in Pennsylvania to test herds only on the application of the owner, and then only where the disease was suspected to exist. It has been impossible, however, to comply with all the requests sent in, and, as far as possible, the worst herds have been picked out for testing. Reacting animals are all condemned and compensation given the owner.

At the time of publication of the last annual report: —

The average appraisement for cattle condemned was \$24.42. Since the beginning of the last fiscal year the appraisement has been \$20.45. The total payments for tuberculous cattle to date (Jan. 1, 1898) amount to \$57,191.16 for 2,510 animals, — an average of \$22.78 per head.

In Pennsylvania the number of cattle tested up to the 1st of June, 1897, was 9,108, the number condemned as tuberculous was 1,839, a percentage of 20.39. Since the 1st of June 4,887 cattle have been tested; of these, 671 were found to be tuberculous and were killed, — a percentage of 13.73. All parts of the State are represented among these herds, as only herds suspected as diseased are tested. It would seem to be fair to assume that many of the worst herds have been discovered, and that the percentage of tuberculosis among cattle at large is being steadily and rapidly reduced.

The report continues : —

It is pleasant to be able to report that there is now a general appreciation of the fact that the State Live Stock Sanitary Board is organized and is working for the suppression of diseases that cause great and burdensome losses every year, and that its function is to check these losses and assist those who are suffering from them. It is recognized by the Board that there are large commercial interests at stake, and that this work should be arranged and conducted so as to interfere as little as possible with the routine of the business of the farmer, and that it should be so managed as to increase confidence in animal products and have a tendency to enlarge the market for them. . . . At the same time, it is believed that the work is without justification unless it has a permanent sanitary value, and succeeds in protecting the public and the general live stock interests, as well as the individual. This community of interests, this plurality of objects to be achieved and of obstacles to be avoided, has given us a problem that has taxed the knowledge and ingenuity of numerous officials and boards in this and other countries.

Whatever objections have been raised in other States to work looking to the suppression of tuberculosis in cattle, they are not based on a desire that the disease shall not be suppressed, but upon the methods employed and the expense involved. Some of the methods in use elsewhere have placed such burdensome restrictions upon dairy farmers that the measures have become exceedingly obnoxious to them; and, in order to obtain a modification of methods, they have in some cases objected to the execution of all plans carried out for the purpose of suppressing tuberculosis. This has caused false impressions, and in some places led to the belief that farmers are opposed to the whole work of suppressing tuberculosis; but in Pennsylvania this is not the case. The farmers here want healthy herds.

Another point that may be of interest, especially as it confirms the experience of the Massachusetts Board, is where they say : —

A few years ago tuberculin was objected to by those who had no experience with it, on the ground that it might injure healthy cattle; but experience covering thousands of cases, extending over years of time, show that this view is groundless; and, with the very large number of animals examined with tuberculin in Pennsylvania, *there has not been a report of a single case in which it was even suspected that the test had caused the slightest injury.*

ILLINOIS.

Illinois has no special legislation or funds for dealing with tuberculosis, but it is dealt with under the general law.

The Live Stock Commission, however, have been conducting tests on herds where the owners apply for it. All animals react-

ing are slaughtered without compensation, the owners having whatever proceeds there may be from the sale of the hide and carcass; where the disease is slight, the beef may be sold, if fit for food.

During the year 36 herds were tested, including 851 animals; of these, 77 were found diseased, or about 9 per cent. (This percentage includes a herd of 151 that had previously been tested.) Of the 77 diseased animals, 41 carcasses were condemned and 36 were passed as fit for food.

The Illinois Live Stock Sanitary Board recommends the enactment of a law compelling all owners of cattle to submit their herds within a specific time to the tuberculin test, reacting animals to be destroyed, the owners receiving stipulated compensation, and only tested animals thereafter admitted to the herd.

MICHIGAN.

Michigan has no special law relating to tuberculosis, but it is handled under the general law relating to contagious diseases of animals. Cattle found to be tuberculous are quarantined and killed. The law does not provide compensation, however, and as a result the commission has met with a good deal of opposition. The commission has followed the plan of testing with tuberculin such herds as have been brought to their attention as suspicious, killing such as react, without compensation.

IOWA.

Iowa has no law on tuberculosis, but proceeds with it as in any contagious disease. The quarantine of all cattle coming into the State for dairy or breeding purposes, unless accompanied by a certificate of tuberculin test, is being advocated.

MINNESOTA.

Minnesota acts through the local board of health, the local board of health notifies the State Board of Health, and it in turn takes action.

All cattle which show symptoms of tuberculosis must be quarantined at once, and the entire herd tested with tuberculin. When cattle have once reacted, the owner has his option of having them killed, or continued in quarantine for a period not to exceed three months, when they are again tested. If they react on the second test, they must be killed within one month. The owner has no compensation for cattle killed, but he is allowed to have them killed under inspection, and if they pass he can dispose of it like any other beef.

MONTANA.

Montana was quarantined against out-of-State cattle recently, by Governor Smith prohibiting the importation of any cattle into the State unless accompanied by a tuberculin test. The State authorities also propose to advocate the testing with tuberculin of all dairy cows supplying the public with milk. Tuberculosis is not common in Montana.

WYOMING.

The sanitary laws in Wyoming are enforced by the State veterinarian. The law permits the veterinarian to destroy cases of tuberculosis, to quarantine suspected or exposed animals, and to prevent the introduction of those diseased.

No changes are contemplated in the present laws relating to contagious diseases of animals.

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REPORT OF THE DELEGATES

TO THE

FARMERS' NATIONAL CONGRESS,

AT FORT WORTH, TEX., 1898.

REPORT OF THE DELEGATES TO THE FARMERS' NATIONAL CONGRESS,*

AT FORT WORTH, TEXAS, 1898.

To His Excellency ROGER WOLCOTT.

SIR : — The delegates from the State of Massachusetts to the Farmers' National Congress, which held its eighteenth annual session at Fort Worth, Tex., Dec. 6-14, 1898, acknowledge the courtesy of your appointment, and submit the following report.

The Congress assembled in the city hall at Fort Worth, which had been assigned for its meetings, and was called to order at 10 o'clock A.M. on Dec. 6, 1898, by Hon. William D. Hoard of Wisconsin, its president.

Delegates numbering some three hundred and fifty were present, from Alabama, Arkansas, Colorado, Georgia, Iowa, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Minnesota, Michigan, Missouri, Nebraska, New York, North Dakota, Ohio, Oklahoma Territory, Pennsylvania, Tennessee, Texas, Mexico and Venezuela.

Prayer was offered by Rt. Rev. Alex. C. Garrett of Dallas, bishop of Texas, after which the Congress was welcomed by Hon. John F. Henderson, the mayor of Fort Worth, by Hon. James E. Mitchell, president of the Fort Worth Protective League, by Hon. W. E. Skinner, president of the Fort Worth Stock Exchange, and by His Excellency Charles A. Culberson, governor of Texas. These addresses were appropriately responded to by the officers of the Congress, after which President Hoard delivered his annual address. A condensed report of the same is as follows : —

* This report has been transmitted to the secretary of the State Board of Agriculture by His Excellency the Governor, and, according to custom, is included in the "Agriculture of Massachusetts."

I congratulate this Congress on the increased hope and encouragement that has come to the homes of the great mass of American farmers the past year. In almost every branch except cotton farming there has been a manifest improvement in prices. Let us hope that our brethren of the cotton field have gained something in economic knowledge, which after all is the key-note to profit everywhere.

Our agriculture is becoming nationalistic. The Farmers' Congress is one of the proofs of this assertion. We are no longer a loosely joined band of States, discordant, belligerent. Thank God we are becoming connected by railroads, navigable rivers, interchangeable products, and a more general commingling of our people. National legislation is taking on thought of this kind in the establishment of experiment stations, the enactment of laws for the better protection of agricultural products against the dishonest greed of men who adulterate and counterfeit.

The march of study, investigation and knowledge have opened to the farmer a new view of the marvellous array of forces around him. Both the farmer and the men of science are coming to see that the farm constitutes a magnificent domain of intellectual conquest.

Every branch of farming is organizing, not only by States, but in a national way, to promote specific knowledge and a wholesome sense of national independence. Never before in the history of this nation has there been such an awakening of intellectual activities, such marshalling of invention, physical research, chemistry and cognate sciences, education and legislation, all in behalf of the American farmer, as at the present time.

We are beginning to feel, as a people, that agriculture is an intellectual as well as a manual pursuit; that from the humblest tenant to the lordliest ranchman progress and profit depend on mental comprehension of the principles involved and an energetic obedience to that comprehension. Comprehension means intellect; obedience means business. Some men are all intellect and no work; others are all work and no intellect. The true farmer unites both. He is a student and a doer of the work.

Some of the questions for this Farmer's Congress to ask of itself are: What can we do in an organized way to help emancipate this great business of farming from a lack of comprehension? How can we contribute as a force to the emancipation of the farm from the wasteful effect of ignorance, and help put in its place the energizing and enriching influences of knowledge? In other words, what can we do to promote farm education? What can this Congress do to promote wise legislation in the State and

national Legislatures to this end? What can this Congress do as a great force to arrest the tendency of the American farmer to destroy the natural fertility of his farm? What can we do to arouse public opinion and the great educational forces of the country to the importance of teaching the elements of agriculture in the primary schools of our land? Our present system of agricultural education is an image with a head of brass, a body of iron and feet of clay. We are directing all our energies to the head and not to the feet.

Our common schools recruit the academy, the college, the university, and they in turn recruit every profession but farming. Our young men flee to the towns and cities, because we have educated them to do so.

Nearly every European country is putting forth efforts to stop this tendency by teaching the elements of scientific agriculture in the common schools. It can be done as easily as the teaching of the elements of scientific arithmetic or chemistry or philosophy. A great host of farmers who were deprived of such teaching find themselves barred from an undertaking of much of the agricultural literature. As a consequence, they turn away from the agricultural college, the bulletin of the experiment station and the farm paper, from that which is really worth anything to them. Had these men been taught in their youth, in the common schools, the meaning of the terms used in agricultural chemistry, something of the principles of animal husbandry, something of the true principles which underlie the preservation of fertility, they would be to-day in much more harmonious relations with all which constitutes agricultural progress. May we not hope that this Congress will create a sentiment that will greatly help along this needed educational reform?

The Farmers' National Congress is a patriotic body. The meaning of patriotism is self-sacrifice. Without sacrifice there can be no patriotism. The very fact that you have assembled here, many from a great distance and at your own expense, gives proof of your public spirit, your anxiety to benefit the cause of agriculture, and of your practical patriotism. The country needs such patriotism. To that we look for the extinction of corruption in politics, the promotion of honest government, the suppression of crime, the encouragement of honest industry, and a just reward to labor as well as to capital.

The Farmers' National Congress is needed as an organizing body of opinion as best it can for national legislation in support of the Department of Agriculture. Our present able and sagacious Secretary of Agriculture is doing what he can to introduce Amer-

ican food products into foreign markets and promote their consumption. That department should have the means to employ, under its own direction, commercial agents in every food market in the world. Denmark sends its agents to England, to receive, guard and look after its shipments of butter and bacon. Canada is doing the same. There is no reason on earth why the United States should not show the same good business sense. Besides, there is a great trade awaiting us at our very doors in the sister republics of the southern part of this continent.

Can we say or do anything here which will move our national Legislature into work of a practical character, in the way of mail subsidies to a line of American steamships sailing direct from our ports to South American ports? I hope we can. It is a reproach to the practical statesmanship of the American people that something has not been done of this character.

We can promote a wide acquaintanceship between the agriculturists of the whole country, teaching ourselves the doctrine that with us there is no north, no south, no east, no west. The invigorating sympathy, welcome and hospitality with which this Congress has been greeted everywhere should build us anew in faith, hope and courage. Just so long as we put our purpose above ourselves, will the people encourage the promotion of the objects and purposes of this organization. We have something more to live for than a mere living. We have, as a class, large duties to perform to the nation, the State and the community. Our standing among men is the true measure of the rights and privileges that will be accorded to us in law or in social relations. We have ourselves, not our stars, to blame if we are underlings. Every other profession pays respect to intellectual power and development. Have they secrets to solve more profound than ours? Have they problems more difficult to comprehend? No. The farmer stands daily in the presence of God's laws, the most profound, the most subtle of all laws to interpret. He shrinks from contention, for he realizes his lack of intellectual training. He submits to unjust laws and systems of taxation. He sees personal property largely exempt and landed property grievously burdened, yet he knows that the true basis of all taxation is the dollar's worth of property, without regard to its character. For his own success in business, he must be better educated as a farmer; for his own protection as a citizen, must study harder and look deeper into his relations with his fellow men in the great social and political compact. He needs so much, and the country needs still more from him—a higher intellectual comprehension of what it means to be an American farmer and an American citizen.

After finishing his address, the president announced that there would be a roll call of States, to elect a committee on resolutions. Mr. Candage was named for Massachusetts.

The committee on credentials reported, which report was accepted.

Hon. W. G. Whitmore of Nebraska read a paper on the "Sugar beet industry," and Prof. A. S. Goets of New Mexico on the same subject.

Senor M. Romero, delegate for Venezuela, read a paper on "The agriculture of Venezuela." *Voted*, To print same with the proceedings of the Congress.

The president announced the following committees: on finance, on location and on the president's address, Mr. Avery of Massachusetts being appointed on the latter.

At the evening session the following resolutions were offered: on the Nicaraguan Canal; on safe-guarding industries threatened by acquisition of new territory; on rural free mail delivery; on good roads and State aid.

Mr. Booker T. Washington of the Tuskegee Industrial Institute of Alabama gave a very interesting address on "Industrial education for the negro."

Mrs. Elinor Ventrice Edwards of Minnesota gave an entertaining address on "The great north-west," illustrated by stereopticon views.

Wednesday, December 7, the Congress was called to order by the president at 10 o'clock A.M., and the following resolutions were presented: on issuing paper money to pay for good roads; on the extension of territory; for laws for sale and lease of arid lands; for laws against noxious weeds; on notice of annual meeting in Appleton's Cyclopedia; for increased appropriation for agricultural display at Paris Exposition.

Mrs. Isidore S. Miner of Texas read a carefully prepared and thoughtful paper on "The organization of country clubs for women."

Mr. Flanders of New York offered resolutions relative to interstate commerce, original importers, and on branding.

Congressman Willingham of Texas made an oral address on "Stock raising in Texas," which was well received.

On motion, the Congress adjourned until 10 A.M. Thursday.

In the afternoon the members of the Congress enjoyed a rough riding and roping contest at the Fort Worth base ball grounds, and in the evening a genuine negro cake walk. These entertainments were generously provided by the citizens of Fort Worth.

December 8 the Congress was called to order by the president, and the following resolutions were presented: favoring liberal appropriations for the improvement of rivers and harbors; favoring an American mail service to foreign countries in American steamships; for more stringent laws against food adulteration; in favor of the beet sugar industry; for reclamation of Mississippi River lands; relative to farmers' institute work; to restrict adulteration of farm and food products; asking Congress to pass more stringent laws against Texas fever; favoring rural free mail delivery; favoring the establishment of textile schools; thanks of the Congress to Governor Culberson and others; for free homes in Oklahoma and the Cherokee strip; that the president appoint a committee to present the resolutions adopted to the President, Congress, etc.

An amendment of the constitution was adopted, as follows: "But no question which in any sense is before the country as a partisan issue, and has been incorporated in the platform of the leading political parties, shall be proposed or debated in the meetings of the Farmers' National Congress." This was added to section 12.

Prof. W. A. Henry, dean of the Wisconsin College of Agriculture, presented an able paper on "Stock feeding," which was discussed by many members. Senors Pablo Martinez del Rio and Ramon Alcazar, delegates from the Republic of Mexico, were introduced to the Congress.

At the afternoon session, reports from the committee on resolutions were adopted. The committee on finance made a partial report. The committee on location reported the recommendation that the next meeting be held in Boston; action on the report postponed until evening.

Hon. E. S. Peters of Texas, president of the Cotton Growers' Association, read a paper on "The cotton interests."

Senor del Rio addressed the Congress on "The general condition of agriculture in Mexico;" and Mr. A. P. Bush, Jr., president of the Cattle Raisers' Association of Texas, addressed the meeting on the "Inter-dependence of the cattle industry on the farm and ranch;" both were ably presented.

Mr. Avery of Massachusetts extended a cordial invitation to the Congress to hold its next meeting in Boston; Mr. Candage seconded the invitation in a five-minute speech from the platform.

Invitations were also extended from the delegates from Colorado and Iowa for the meeting to be held in those States.

Voted, That the secretary of the Farmers' National Congress enroll as honorary members Gen. Ignacio Andrade, president of Venezuela; Senor Nicolas Rolando, secretary of agriculture of Venezuela; Gen. Porfirio Diaz, president of Mexico; and Ingenier Tr. Manuel Fernandez Leal, secretary of agriculture of Mexico; also to enroll as members delegates from those countries.

At the evening session the president called Mr. Funk of Illinois to the chair, and withdrew on account of illness.

Mr. Evans of Colorado moved that further consideration of the report of the committee on location be deferred until to-morrow (Friday) morning. The motion was debated by ten or a dozen members, when Mr. Ballard of Kansas moved to amend by postponing till 8.30 A.M. Friday. Amendment adopted. A roll call of States was demanded on the main question, and it was lost. A motion was made to proceed to vote on the question of location at once, and that it be by roll call of States. Calling the roll of States began, but had not proceeded far when Mr. Willington of Texas moved, and Mr. Clayton of Iowa seconded the motion, to adopt the report of the committee on location by acclamation, which was carried.

The committee on finance reported it necessary to levy an assessment of one dollar per delegate. The report was adopted.

The committee on resolutions reported favorably on eight resolutions and unfavorably on six. The report was adopted.

Professor Whitney, chief of the Bureau of Soil Analysis, Department of Agriculture, briefly addressed the Congress, expressing the regret of the Secretary of Agriculture that he could not be present, and also stated very interesting facts in regard to tobacco culture and cure.

Adjourned until 9 A.M. Friday.

Friday, December 9, the Congress was called to order at 9 A.M., Mr. Funk of Illinois in the chair.

Moved by Mr. Stout of Iowa, that Mr. Candage of Massachusetts be added to the executive committee; and by the same, that Mr. Avery of Massachusetts be assistant treasurer, which were adopted.

The committee to engross and present resolutions to the President of the United States and Speaker of the House of Representatives was announced as follows: Messrs. Clayton of Iowa, Candage of Massachusetts, Powell of Pennsylvania, Purse of Georgia and Evans of Colorado.

Motion was made and carried that the secretary mail five copies of the annual report to each governor of the various States, at least twenty copies to the Department of Agriculture, and one copy to each registered delegate of this meeting.

Mr. Candage of Massachusetts addressed the Congress on "An American mail service in American steamships."

The Congress then adjourned, subject to the call of the president.

The members of the Congress, and their ladies, to the number of three hundred and fifty, took a special train in the afternoon for Houston, two hundred and eighty-eight miles distant, where they arrived past midnight, and there spent the remainder of the night and the next day. The citizens of Houston did all in their power, through well-appointed committees, to provide for the pleasure and comfort of their guests.

Saturday, December 10, at evening, left Houston for Galveston, a distance of fifty-three miles, where the delegates spent the night and the next day, Sunday. They were taken around the harbor and out to the breakwaters in a tug and barge, looked over the town, which is a pleasant one, and at evening returned to Houston and spent the night.

Monday morning, December 12, started for San Antonio. On the way the train stopped at Sugar Lands where, through the courtesy of Colonel Cunningham, the excursionists were permitted to inspect his sugar mill, the largest in Texas and second largest in the country. The next stop was at a cattle ranch, where they saw some fine stock, and among them several India buffalo bulls.

At Victoria the train stopped for lunch, which the citizens had gratuitously provided, and to which the good appetites of the excursionists did justice. Speeches were made by citizens of the city, and responded to by the excursionists. Each delegate was given a silk badge, in honor and in memory of Victoria. As the train rolled away from the depot, cheers rent the air, hands waved and handkerchiefs fluttered until they faded from sight.

The next stop was Cuero, where the party was welcomed by delegated citizens; more speeches, more badges, a short turn about town, and the whistle sounded. Then the party bade good-bye to the warm-hearted people of the town, and sped on their way towards San Antonio, which was reached at 9 o'clock P.M.

San Antonio is one of the oldest, largest and most interesting of all the cities and towns in Texas. It contains some forty-five thousand inhabitants, is well laid out, has handsome buildings, good hotels, and includes in it the famous Alamo, and some old Spanish missions. The delegates spent two nights and a day at San Antonio very pleasantly and profitably, and had they not visited the city they would have missed the greatest pleasure of the excursion. They left San Antonio at 7 A.M. on December 14, there being four inches of snow in the streets, — almost an unheard-of occurrence there, and the train rolled away for Waco, an all-day ride. Being informed that there would be no stop for dinner on the route, the excursionists provided themselves with a cold lunch, to be eaten and enjoyed on the trip. The train reached Waco at 9 o'clock P.M., where a band of music met it at the depot, and committees escorted the excursionists to their different hotels. Waco was not behind its sister cities in its badges and courtesies, the only drawback being the short time allotted to enjoy their friendliness and hospitality.

Here the final meeting of the Congress was held, December 15; speeches of welcome were made by the citizens and responded to by Mr. Candage on the part of the Congress, and the following resolutions were adopted:—

Resolved, That thanks are due and are hereby tendered to the citizens of Houston, a few citizens of Galveston, Colonel Cunningham of Sugar Lands, the citizens of Victoria, Cuero, San Antonio, Waco and Fort Worth, who so generously contributed to the comfort, pleasure and welfare of the members of the Farmers' National Congress on their extended trip through the great State of Texas; to the railroads for contributing to their comfort and safe conduct; to Col. D. O. Lively for his untiring efforts to make the excursion an education and a pleasure to all members and their ladies who chose to avail themselves of it; and to all who furnished badges and pinned them upon us; and be it further

Resolved, That a copy of these resolutions be furnished to the press for publication.

The forenoon was spent in seeing the sights of Waco, where the committees and citizens were untiring in efforts to make the stay in their city a pleasant one. But the time arrived to bid them adieu and to hasten to the end of the journey, Fort Worth, which was reached the same evening without accident, all in good health and spirits, notwithstanding the twelve hundred miles travel on the excursion.

The next morning the delegates bade adieu to Fort Worth and started for their distant homes, carrying with them pleasing memories of their contact with the people and their stay in the great State of Texas.

TO CONCLUDE, — A WORD OR TWO ABOUT TEXAS.

The great State of Texas, with its area of 265,785 square miles, would make thirty-three States of the size of Massachusetts; and, were all the population of the United States centred in Texas, it would not be as thickly populated per square mile as is the State of Massachusetts at this writing. In 1890 it contained 2,235,523 inhabitants; it is now claimed to have 3,500,000.

With its diversity of climate and soil, it is capable of producing the products of the tropics and of the temperate zone.

Its soil is fruitful, and only needs tillers to make it produce crops that would astonish the world. In 1898 it produced one-third of the cotton crop of the United States; it is the great cattle-raising State; it can be made to produce wheat, corn and other cereals to supply the markets of this continent; and in the production of sugar cane, fruits and vegetables its possibilities are wonderful. It has made great strides in agriculture, manufactures and in general development in the last ten years, and will probably make greater in the next decade. For young men it is an inviting field of labor.

R. G. F. CANDAGE,

For Massachusetts Delegation.

Boston, Jan. 28, 1899.

FINANCIAL RETURNS

AND

ANALYSES OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH MEMBERSHIP AND INSTITUTES,

FOR THE YEAR 1898.

RETURNS OF SOCIETIES.

AMESBURY AND SALISBURY AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1881, Acts of 1881, chapter 204.

Originally raised by contribution, \$1,002.32; now has \$8,241.05 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$8,544.77: real estate, \$7,873.29; crockery, tables, etc., \$367.76; cash on hand, \$303.72. Total liabilities consist of notes to the amount of \$1,900. Receipts in 1898, \$2,351.16: bounty, \$600; new members, \$21; donations, \$16.80; other sources, \$1,713.36. Expenditures in 1898, \$2,087.65: premiums and gratuities paid, \$735.05; current running expenses, \$205.50; interest, \$121; other expenses, \$1,026.10. The society offered \$1,600 in premiums, awarded \$735.05 in premiums and gratuities, and paid \$720.50, which went to 19 cities and towns. Seventy-three dollars went to 6 towns outside the State. Five hundred and thirty-five persons received premiums and 25 gratuities. Under head of farms \$26 was awarded; under farm and pet stock \$288 was awarded; under farm and garden products \$163.90 was awarded; under dairy products \$3.25 was awarded; under domestic manufactures \$99.20 was awarded; under objects strictly agricultural, not specified, \$20 was awarded; under objects other than agricultural, not specified, \$134.65 was awarded. The society reports 246 members, — 213 males and 33 females. Three farmers' institutes were held: at Amesbury, January 26, on "Market gardening" and "The care and feed of dairy cows;" at Newbury, February 11, on "Paying crops for small farms" and "Poultry farming;" and at Amesbury, February 23, on "Economical feed for dairy cows" and "The New England farmer."

BARNSTABLE COUNTY AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 114.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be \$1,740; now has \$8,300 invested as a capital stock in real estate and bonds. Total assets, \$8,941.41: real estate, \$7,500; bonds, \$800; cash on hand, \$641.41. Total liabilities consist of mortgages or like liabilities to the amount of \$3,575. Receipts in 1898, \$3,922.03: bounty, \$600; bonds, \$10; new members, \$45; donations, \$41; other sources, \$3,226.03. Expenditures in 1898, \$3,280.62: premiums and gratuities paid, \$1,414.80; current running expenses, \$1,698.82; interest, \$167. The society offered \$1,414.80 in premiums, and awarded and paid \$1,414.80 in premiums and gratuities, which went to 7 towns. One hundred and twenty-five persons received premiums and 236 gratuities. Under head of farms \$5 was awarded; under farm and pet stock \$422.50 was awarded; under field and garden crops \$19 was awarded; under farm and garden products \$151.45 was awarded; under dairy products \$5 was awarded; under domestic manufactures \$207.85 was awarded; under agricultural implements \$4 was awarded; under trotting \$580 was paid; under objects other than agricultural, not specified, \$20 was awarded. The society reports 547 members,—306 males and 241 females. Three farmers' institutes were held: at Yarmouthport, February 10, on "The reflections of a modern hayseed;" at West Barnstable, February 25, on "Barnyard manure and commercial fertilizers: what they are and how to use them" and "Salt hay and how to feed it;" and at East Sandwich, March 4, on "Poultry culture and market gardening."

BERKSHIRE AGRICULTURAL SOCIETY.

Incorporated 1811, Acts of 1811, chapter 70.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$3,000; now has \$12,000 invested as a capital stock in real estate. Total assets, \$12,781.08: real estate, \$12,000; crockery,

tables, etc., \$200; bills due and unpaid, \$302; cash on hand, \$279.08. Total liabilities, \$9,148.66: premiums due and unpaid, \$1,381.75; outstanding bills, \$766.91; mortgages or like liabilities, \$7,000. Receipts in 1898, \$5,740.84: bounty, \$600; new members, \$84; other sources, \$5,056.84. Expenditures in 1898, \$5,461.76: premiums paid, \$70.75; current running expenses, \$4,519.80; interest, \$350; other expenses, \$521.21. The society offered \$2,064 in premiums, awarded \$1,452.50 and paid \$70.75, premiums being awarded to 30 cities and towns. One hundred and forty-nine dollars and fifty cents went to 8 cities and towns outside the State. Two hundred and sixty-two persons received premiums. Under head of farms \$45 was awarded; under farm and pet stock \$815.50 was awarded; under field and garden crops \$91 was awarded; under farm and garden products \$197.25 was awarded; under dairy products \$16 was awarded; under domestic manufactures \$222.75 was awarded; under trotting \$1,200 was paid; under objects other than agricultural, not specified, \$65 was awarded. Under objects strictly agricultural, not specified, 2,700 lbs. of phosphate, given by Howard & Morrow, was awarded and paid. The society reports 936 members, — 863 males and 73 females. Three farmers' institutes were held: at Hinsdale, January 27, on "How to secure good roads, with or without State aid" and "Economical summer and winter feeds for milch cows;" at Pittsfield, December 1, on "The land registration act, otherwise known as the Torrens law;" and at Dalton, December 27, on "Dairying and growing of fodder crops."

BLACKSTONE VALLEY AGRICULTURAL SOCIETY.

Incorporated 1884, Acts of 1884, chapter 48.

Originally raised by contribution, \$3,000; now has \$4,500 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$4,500: real estate, \$4,400; crockery, tables, etc., \$100. Total liabilities, \$2,013.05: outstanding bills, \$13.05; mortgages or like liabilities, \$2,000. Receipts in 1898, \$2,594.24: bounty, \$600; new members,

\$24; donations, \$29.71; other sources, \$1,940.53. Expenditures in 1898, \$2,540.53: premiums and gratuities paid, \$594.67; current running expenses, \$1,727.86; interest, \$90.50; other expenses, \$127.50. The society offered \$900 in premiums, awarded \$648.38 in premiums and gratuities, and paid \$594.67, which went to 15 cities and towns. Two dollars went to one town outside the State. One hundred and twenty-nine persons received premiums and 20 gratuities. Under head of farms \$68 was awarded; under farm and pet stock \$442.03 was awarded; under field and garden crops \$18 was awarded; under farm and garden products \$60 was awarded; under dairy products \$3 was awarded; under domestic manufactures \$24.50 was awarded; under trotting and bicycle race \$47 was paid; under objects other than agricultural, not specified, \$35.85 was awarded. The society reports 551 members,—280 males and 271 females. Three farmers' institutes were held at Uxbridge: February 5, on "How to make New England agriculture more profitable;" March 8, on "The cultivation and marketing of fruit;" and April 5, on "Which are the most profitable to the farmer, ducks or hens?"

BRISTOL COUNTY AGRICULTURAL SOCIETY.

Incorporated 1823, Acts of 1823, chapter 32.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$3,240; now has \$32,000 invested as a capital stock in real estate. Total assets, \$33,225: real estate, \$32,000; crockery, tables, etc., \$400; cash on hand, \$825. Total liabilities, \$11,048.75; premiums due and unpaid, \$48.75; mortgages or like liabilities, \$11,000. Receipts in 1898, \$15,105.12: bounty, \$600; new members, \$60; other sources, \$14,445.12. Expenditures in 1898, \$14,987.88: premiums and gratuities paid, \$5,631.65; current running expenses, \$7,658.82; interest, \$573.50; other expenses, \$1,123.91. The society offered in premiums \$7,075, awarded \$5,680 in premiums and gratuities, and paid \$5,631.65, which went to 49 cities and towns. Seven hundred and thirty-nine dollars and

twenty cents went to 11 cities and towns outside the State. Seven hundred and seventy-two persons received premiums and 12 gratuities. Under head of farms \$52 was awarded; under farm and pet stock \$1,772 was awarded; under field and garden crops \$56 was awarded; under farm and garden products \$403 was awarded; under dairy products \$44 was awarded; under domestic manufactures \$324.90 was awarded; under trotting \$2,470 was paid; under objects other than agricultural, not specified, \$558.50 was awarded. The society reports 862 members, — 662 males and 200 females. Three farmers' institutes were held: at Dighton, March 4, on "Fruit culture and spraying in New England;" at New Bedford, March 25, on "The work and influence of the Massachusetts Agricultural College" and "Germination and growth of plants;" and at Seekonk, March 28, on "Raising and marketing fruit."

DEERFIELD VALLEY AGRICULTURAL SOCIETY.

Incorporated 1871, Acts of 1871, chapter 208.

Originally raised by contribution, \$4,094.01; now has \$9,200 invested as a capital stock in real estate. Total assets, \$9,512.42: real estate, \$9,200; crockery, tables, etc., \$250; cash on hand, \$62.42. Total liabilities consist of mortgages or like liabilities to the amount of \$500. Receipts in 1898, \$2,704.25: bounty, \$600; new members, \$27; donations, \$24.75; other sources, \$2,052.50. Expenditures in 1898, \$1,972.50: premiums paid, \$1,116.65; current running expenses, \$701.72; interest, \$29.13; other expenses, \$125. The society offered in premiums \$1,449, awarded \$1,141.40 and paid \$1,116.65, which went to 24 cities and towns. One dollar went to one city and one town outside the State. It is estimated that 250 persons received premiums. Under head of farm and pet stock \$536 was awarded; under farm and garden products \$67.45 was awarded; under dairy products \$7 was awarded; under domestic manufactures \$95.20 was awarded; under trotting \$350 was paid; under objects other than agricultural, not specified, \$85.75 was awarded. The society

reports 1,112 members, — 865 males and 247 females. Three farmers' institutes were held at Shelburne Falls, January 29, on "The latest information concerning the production, composition and handling of milk and cream" and "Taxation and the farmer;" at Ashfield, February 23, on "The State and the school;" and at Charlemont, December 3, on "Reminiscences of the Orient."

EASTERN HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 156.

Originally raised by contribution, \$3,000; now has \$7,000 invested as a capital stock in real estate. Total assets, \$7,028.58: real estate, \$7,000; bills due and unpaid, \$5; cash on hand, \$23.58. Total liabilities, \$4,110.23: premiums due and unpaid, \$69.59; outstanding bills, \$530.64; mortgages or like liabilities, \$3,510. Receipts in 1898, \$3,321.67: bounty, \$600; new members, \$20; donations, \$158.50; other sources, \$2,543.17. Expenditures in 1898, \$3,297.09: premiums and gratuities paid, \$1,394.91; interest, \$206.15; other expenses, \$1,696.03. The society offered \$2,147.25 in premiums, awarded \$1,464.50 in premiums and gratuities and paid \$1,394.91, which went to 20 cities and towns. Twenty-five dollars went to one town outside the State. One hundred and twenty-one persons received premiums and gratuities. Under head of farms \$18 was awarded; under farm and pet stock \$605 was awarded; under farm and garden products \$150.25 was awarded; under dairy products \$6 was awarded; under domestic manufactures \$39.75 was awarded; under objects strictly agricultural, not specified, \$14.50 was awarded. The society reports 476 members, — 282 males and 194 females. Three farmers' institutes were held: at Belchertown, January 19, on "By-products of our dairies" and "Obstacles to successful farming, and how to overcome them;" at Monson, February 18, on veterinary subjects; and at Palmer, March 1, on "Fertilizers: what, when and how to buy and use."

ESSEX AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 25.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$9,363.66; now has \$28,500 invested as a capital stock in real estate, stocks, crockery, tables, etc. Total assets, \$28,500: real estate, \$15,300; stocks, \$13,000; crockery, tables, etc., \$200. Receipts in 1898, \$3,156.39: bounty, \$600; notes, \$39.10; stocks, \$807.21; new members, \$99; donations, \$161.75; other sources, \$1,449.33. Expenditures in 1898, \$3,928.15: premiums paid, \$1,509; current running expenses, \$742.08; interest, \$510.15; other expenses, \$1,166.92. The society awarded \$1,509* in premiums and paid \$1,408.50* which went to 30 cities and towns. Three hundred and eighty-one persons received premiums. Under head of farms \$50 was awarded; under farm and pet stock \$738.50 was awarded; under field and garden crops \$58 was awarded; under farm and garden products \$373.50 was awarded; under dairy products \$1 was awarded; under domestic manufactures \$140.25 was awarded; under agricultural implements \$62 was awarded; under objects strictly agricultural, not specified, \$43 was awarded; under objects other than agricultural, not specified, \$68.75 was awarded. The society reports 1,306 members,—1,291 males and 15 females. Four farmers' institutes were held: at West Newbury, January 21, on "A grange: what, why and how;" and "Good, better, best methods of producing and selling milk;" at Beverly, February 11, on "Poultry culture" and "Farming forward;" at Newbury, March 4, on "Apple and fruit culture for profit;" and at Salem, March 25, on "Advances in horticulture" and "Roadside improvement."

* Amounts paid for 1897; awarded for 1898.

FRANKLIN COUNTY AGRICULTURAL SOCIETY.

Incorporated 1850, Acts of 1850, chapter 104.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$3,768; now has \$4,000 invested as a capital stock in real estate and stocks. Total assets, \$4,005.98: real estate, \$3,000; stocks, \$1,000; cash on hand, \$5.98. Total liabilities, \$3,255: premiums due and unpaid, \$80; outstanding bills, \$225; mortgages or like liabilities, \$2,950. Receipts in 1898, \$4,420.52: bounty, \$600; stocks, \$40; new members, \$15; donations, \$521; other sources, \$3,244.52. Expenditures in 1898, \$4,414.54: premiums paid, \$1,036.05; current running expenses, \$2,796.43; interest, \$151.25; other expenses, \$430.81. The society offered \$1,800 in premiums and paid \$1,036.05, which went to 25 cities and towns. Approximately 250 persons received premiums. Under head of farm and pet stock \$894.15 was awarded; under farm and garden products \$110 was awarded; under dairy products \$10 was awarded; under domestic manufactures \$70.40 was awarded; under trotting \$750 was paid. The society reports about 1,800 members. Three farmers' institutes were held: at Shelburne Falls, January 29, on "The latest information concerning the production, composition and handling of milk and cream" and "Taxation and the farmer;" at Montague, February 25, on "Dairy farming" and "Farming as a business;" and at Greenfield, March 19, on "The milch cow" and "The horse: breeding for pleasure and profit."

HAMPSHIRE AGRICULTURAL SOCIETY.

Incorporated 1814, Acts of 1814, chapter 19.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$3,255.26; now has \$4,422.43 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$4,422.43: real estate, \$4,200; crockery, tables, etc., \$222.43. Total liabilities, \$1,325.44: outstanding bills, \$12.44; mortgages or like liabilities, \$1,313. Receipts in 1898, \$1,944.78: bounty,

\$600 ; new members, \$70 ; donations, \$74.24 ; other sources, \$1,200.54. Expenditures in 1898, \$1,957.32 : premiums and gratuities paid, \$616.90 ; current running expenses, \$1,027.46 ; interest, \$64 ; other expenses, \$248.96. The society offered \$862.25 in premiums and awarded and paid \$616.90 in premiums and gratuities, which went to 17 cities and towns. Five dollars went to one city and one town outside the State. Two hundred and thirty persons received premiums and 2 gratuities. Under head of farm and pet stock \$342 was awarded ; under farm and garden products \$194 was awarded ; under dairy products \$3 was awarded ; under domestic manufactures \$39.40 was awarded ; under agricultural implements \$10 was awarded ; under trotting \$525 was paid ; under objects other than agricultural, not specified, \$28.90 was awarded. The society reports 837 members, — 590 males and 247 females. Three farmers' institutes were held : at Hadley, February 18, on " German farms and farming " and " Book farming v. moon farming ; " at Montague, February 25, on " Dairy farming " and " Farming as a business ; " and at Amherst, March 5, on " Mutual relations of creamery patrons and experiment stations."

HAMPSHIRE, FRANKLIN AND HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 125.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$8,141.29 ; now has \$2,535.97 invested as a capital stock in personal property. Total assets, \$2,660.97 : real estate lease, \$800 ; bank funds, \$643.08 ; crockery, tables, etc., \$910 ; bills due and unpaid, \$125 ; cash on hand, \$182.89. Total liabilities consist of outstanding bills to the amount of about \$125. Receipts in 1898, \$3,696.95 : bounty, \$600 ; new members, \$121 ; other sources, \$2,975.95. Expenditures in 1898, \$2,896.22 : premiums and gratuities paid, \$1,200.71 ; current running expenses, \$1,507.26 ; other expenses, \$188.25. The society offered \$1,682.75 in premiums, awarded \$1,322.66 in premiums and gratuities and paid \$1,200.71, which went

to 31 cities and towns. Twenty-nine dollars went to two cities outside the State. Two hundred and seventeen persons received premiums and 24 gratuities. Under head of farm and pet stock \$895.50 was awarded; under field and garden crops \$37 was awarded; under farm and garden products \$169.25 was awarded; under dairy products \$14 was awarded; under domestic manufactures \$48.45 was awarded; under objects strictly agricultural, not specified, \$25 was awarded; under trotting \$790 was paid; under objects other than agricultural, not specified, \$143.96 was awarded. The society reports 1,075 members, — 850 males and 225 females. Four farmers' institutes were held: at Northampton, January 5, on "The Channel Islands and their agriculture;" at Southampton, January 28, on "The improvement of country roads" and "How to make New England agriculture more profitable;" at Hadley, February 18, on "German farms and farmers" and "Book farming v. moon farming;" and at South Hadley, March 11, on "Taxation from the farmer's stand-point" and "Selection of the dairy cow."

HIGHLAND AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 145.

Originally raised by contribution \$3,262; now has \$3,150 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$3,210.25: real estate, \$3,000; crockery, tables, etc., \$150; cash on hand, \$60.25. Receipts in 1898, \$1,679.81: bounty, \$600; new members, \$22; other sources, \$1,057.81. Expenditures in 1898, \$1,619.56: premiums paid, \$691.85; current running expenses, \$896.85; interest, \$3.11; other expenses, \$27.75. The society offered \$813.05 in premiums and awarded and paid \$691.85, which went to 27 cities and towns. Eighty-five cents went to one city outside the State. One hundred and sixty-four persons received premiums. Under head of farm and pet stock \$428 was awarded; under field and garden crops \$20.50 was awarded; under farm and garden products \$45.65 was awarded; under dairy products \$5 was awarded; under domestic manufactures \$82.95 was awarded; under agricult-

ural implements \$4.50 was awarded; under trotting \$80 was paid; under objects other than agricultural, not specified, \$25.25 was awarded. The society reports 404 members, — 279 males and 125 females. Three farmers' institutes were held: at Hinsdale, January 27, on "Good roads, with or without State aid" and "Economical summer and winter feeds for dairy cows;" at Middlefield, September 7, on "What can the farmer do to receive better pay for his labor than he is now receiving?" and at Middlefield, October 31, on "The farm: its products and profits."

HILLSIDE AGRICULTURAL SOCIETY.

Incorporated 1883, Acts of 1883, chapter 112.

Originally raised by contribution, \$3,113.32; now has \$6,265.38 invested as a capital stock in real estate, bank funds, cash, crockery, tables, etc. Total assets, \$6,265.38: real estate, \$4,760.61; bank funds, \$982; crockery, tables, etc., \$350; cash on hand, \$172.77. Receipts in 1898, \$1,708.29: bounty, \$600; bank fund, \$33.20; new members, \$132; donations, \$18.12; other sources, \$924.97. Expenditures for 1898, \$1,799.98: premiums paid, \$814.65; current running expenses, \$727.16; other expenses, \$258.17. The society offered \$808 in premiums, awarded \$815.15 and paid \$814.65, which went to 20 cities and towns. Three hundred and sixty-one persons received premiums. Under head of farms \$54.50 was awarded; under farm and pet stock \$402.35 was awarded; under field and garden crops \$49 was awarded; under farm and garden products \$86.50 was awarded; under dairy products \$16 was awarded; under domestic manufactures \$81.80 was awarded; under agricultural implements \$4.50 was awarded; under objects strictly agricultural, not specified, \$46 was awarded; under trotting \$50 was paid; under objects other than agricultural, not specified, \$24 was awarded. The society reports 763 members, — 730 males and 33 females. Four farmers' institutes were held: at Cummington, February 19, on "Poultry for profit" and "Economical summer and winter feeds for dairy cows;" at Ashfield, February 23, on "The

State and the school;" at Chesterfield, February 26, on "Lameness in horses, cause and effect" and "Economical summer and winter feeds for dairy cows;" and at Cummington, September 27, on "Climate, soil and products of Missouri" and "The influence of the State Board of Agriculture."

HINGHAM AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 99.

Originally raised by contribution \$17,406.15; now has \$22,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$22,133.82: real estate, \$20,000; crockery, tables, etc., \$2,000; cash on hand, \$133.82. Total liabilities consist of notes to the amount of \$500. Receipts in 1898, \$2,547.61: bounty, \$600; new members, \$5; donations, \$52.60; other sources, \$1,890.01. Expenditures in 1898, \$2,416.24: premiums and gratuities paid, \$676.86; current running expenses, \$531.23; interest, \$31.77; other expenses, \$1,176.38. The society offered \$1,741.85 in premiums and awarded and paid \$676.86 in premiums and gratuities, which went to 11 cities and towns. One hundred and thirty-one persons received premiums and 161 gratuities. Under farm and garden products \$535.86 was awarded; under dairy products \$6 was awarded; under domestic manufactures \$73 was awarded; under objects other than agricultural, not specified, \$62 was awarded. The society reports 693 members,—491 males and 202 females. Eight farmers' institutes were held at Hingham: January 10, on "What breed of fowls is most desirable for the production of eggs and poultry?" February 7, on "The Board of Agriculture and the Experiment Station, what they have done and what they are doing for the farmers of Massachusetts;" March 14, on "Originating and training new varieties of vegetables;" May 2, on "Poultry farming;" June 27, on "Our national flower" and "A chorus of birds;" August 1, on Questions from the question box; August 29, on "Spraying fruit," "Mildew and its cause" and "Ploughing under green crops;" and November 14, on "The chrysanthemum in this country and Japan."

HOOSAC VALLEY AGRICULTURAL SOCIETY.

Incorporated 1860, Acts of 1860, chapter 56.

Originally raised by contribution \$2,006; now has \$17,260.49 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$17,626.58: real estate, \$16,760.49; crockery, tables, etc., \$500; cash on hand, \$366.09. Receipts in 1898, \$6,773.90: bounty, \$600; other sources, \$6,173.90. Expenditures in 1898, \$7,050.95: premiums paid, \$1,477.90; current running expenses, \$3,071.95; interest, \$281.50; other expenses, \$2,219.60. The society offered \$4,249.25 in premiums, awarded \$2,745.50 and paid \$2,512.80, which went to 21 cities and towns. One hundred and fifty-five dollars and seventy-five cents went to 8 cities and towns outside the State. Two hundred and forty-three persons received premiums. Under head of farms \$18 was awarded; under farm and pet stock \$625.50 was awarded; under field and garden crops \$161 was awarded; under farm and garden products \$149.75 was awarded; under dairy products \$20.50 was awarded; under domestic manufactures \$312.50 was awarded; under agricultural implements \$20 was awarded; under trotting \$1,320 was paid; under objects other than agricultural, not specified, \$118.25 was awarded. The society reports 983 members,—967 males and 16 females. Three farmers' institutes were held: at Williamstown, January 28, on "Fertilizers and materials from which they are made;" at Cheshire, December 15, on "How to feed the milch cow and the soil;" and at South Williamstown, December 22, on "The cost of a quart of milk" and "The cultivation of Indian corn."

HOUSATONIC AGRICULTURAL SOCIETY.

Incorporated 1848, Acts of 1848, chapter 101.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$6,335.33; now has \$23,178.53 invested as a capital stock in real estate, stocks and bank funds. Total assets, \$23,792.32: real estate, \$21,000; stocks, \$1,000; bank funds, \$1,178.53:

crockery, tables, etc., \$475.47; bills due and unpaid, \$15; cash on hand, \$123.32. Total liabilities, \$4,182: premiums due and unpaid and outstanding bills, \$150; notes, \$4,032. Receipts in 1898, \$10,802.23: bounty, \$600; stocks, \$50; bank funds, \$43.06; new members, \$188; donations, \$80; other sources, \$9,841.17. Expenditures in 1898, \$10,078.91: premiums and gratuities paid, \$2,163.75; current running expenses, \$3,599.52; interest, \$162.50; insurance, \$188; other expenses, \$3,965.14. The society offered \$2,589.50 in premiums, awarded \$2,250 in premiums and gratuities and paid \$2,163.75, which went to 17 cities and towns. Four hundred and ninety-eight persons received premiums and gratuities. Under head of farm and pet stock \$1,155.05 was awarded; under field and garden crops \$245 was awarded; under farm and garden products, \$306 was awarded; under dairy products \$42 was awarded; under domestic manufactures \$389.55 was awarded; under trotting \$1,885 was paid; under objects other than agricultural, not specified, including sports, \$971.91 was awarded. The society reports 1,700 members,—1,659 males and 41 females. Three farmers' institutes were held: at Sheffield, March 4, on "The demands of the future upon the New England farmer;" at Great Barrington, April 26, on "The profitable production of potatoes;" and at Great Barrington, December 23, on "The business side of farming."

MANUFACTURERS' AGRICULTURAL SOCIETY OF NORTH ATTLEBOROUGH.

Incorporated 1896, Acts of 1896, chapter 260.

Originally raised by contribution, \$10,000; now has \$10,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$10,053.65: real estate, \$9,500; crockery, tables, etc., \$500; cash on hand, \$53.65. Receipts in 1898, \$4,394.31: bounty, \$600; other sources \$3,794.31. Expenditures in 1898, \$4,394.31: premiums and gratuities paid, \$744; current running expenses, \$3,296.54; other expenses, \$353.77. The society offered \$1,215.55 in premiums, and awarded and paid \$744 in premiums and

gratuities, which went to 17 cities and towns. Ten dollars and twenty-five cents went to four cities and towns outside the State. Two hundred and thirty-one persons received premiums and 46 gratuities. Under head of farm and pet stock \$455.80 was awarded; under farm and garden products \$161.35 was awarded; under dairy products \$2.50 was awarded; under domestic manufactures \$64.15 was awarded; under trotting \$1,275 was paid; under objects other than agricultural, not specified, \$60.20 was awarded. The society reports 72 male members. Three farmers' institutes were held at Attleborough: March 18, on "How to keep up the fertility of the soil;" April 12, on "Practical poultry culture;" and December 29, on "Good hay crops and how to get them."

MARSHFIELD AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 116.

Originally raised by contribution, \$3,755.43; now has \$27,980.08 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$27,980.08: real estate, \$26,472.78; crockery, tables, etc., \$1,507.30. Total liabilities, \$5,095.05: premiums due and unpaid, \$25.05; mortgages or like liabilities, \$5,070. Receipts in 1898, \$3,022.01: bounty, \$600; donations, \$6; other sources, \$2,416.01. Expenditures in 1898, \$3,066.21: premiums and gratuities paid, \$1,141.40; interest, \$516.75; other expenses, \$1,408.06. The society offered \$1,466 in premiums, awarded \$1,018.20 in premiums and gratuities and paid \$993.15, which went to 30 cities and towns. Thirty cents went to one city outside the State. Sixty-nine persons received premiums and 263 gratuities. Under head of farms \$8 was awarded; under farm and pet stock \$155.95 was awarded; under farm and garden products \$180.35 was awarded; under dairy products \$1 was awarded; under domestic manufactures \$131 was awarded; under trotting \$692.50 was paid. The society reports 764 members, — 500 males and 264 females. Four farmers' institutes were held at Marshfield: February 17, on "Poultry;" June 18, on

“Plants and flowers;” November 22, on “How to conduct an agricultural society;” and December 21, on “Obstacles to successful farming, and how to overcome them.”

MARTHA'S VINEYARD AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 33.

Originally raised by contribution, \$4,552.17; now has \$4,371.64 invested as a capital stock in real estate, notes, bank funds, crockery, tables, etc. Total assets, \$4,434.53: real estate, \$2,750; notes, \$400; bank funds, \$1,021.64; crockery, tables, etc., \$200; cash on hand, \$62.89. Total liabilities, \$54: premiums due and unpaid, \$14; outstanding bills, \$40. Receipts in 1898, \$1,376.13: bounty, \$600; notes, \$29.33; bank funds, \$39.31; new members, \$4; other sources, \$703.49. Expenditures in 1898, \$1,575.05: premiums and gratuities paid, \$773.03; current running expenses, \$272.53; other expenses, \$529.49. The society offered \$1,032.75 in premiums, awarded \$787.03 in premiums and gratuities and paid \$773.03, which went to 6 towns. Sixty-two persons received premiums and 145 gratuities. Under head of farms \$5 was awarded; under farm and pet stock \$255 was awarded; under field and garden crops \$39 was awarded; under farm and garden products \$159.64 was awarded; under dairy products \$13.75 was awarded; under domestic manufactures \$128.14 was awarded; under trotting \$125.25 was paid; under objects other than agricultural, not specified, \$95.85 was awarded. The society reports 190 members, — 101 males and 89 females. Four farmers' institutes were held at West Tisbury: May 9, on “The relative value of different kinds of forage crops;” July 25, on “What is the best paying crop that can be raised on the island?” September 22, on “Fruit culture;” and December 15, on “Corn raising.”

MASSACHUSETTS HORTICULTURAL SOCIETY.

Incorporated 1829, Acts of 1829, chapter 22.

The first investment was from surplus, Jan. 16, 1835, and amounted to \$525. The society now has \$247,000 invested as a capital stock in real estate, furniture and library. Total

assets, \$482,689.96 : real estate, \$250,000 ; loan, \$7,500 ; bonds, \$156,202.25 ; library, furniture, etc., \$46,006.18 ; bills due and unpaid, \$8,875.93 ; cash on hand, \$14,105.60. Total liabilities, \$9,100 : premiums due and unpaid, \$8,100 ; mortgages or like liabilities, \$1,000. Receipts in 1898, \$171,902.68 : bounty, \$600 ; notes, \$953.87 ; bonds, \$5,105 ; bank funds, \$391.84 ; new members, \$1,010 ; donations, \$144,333.33 ; other sources, \$19,508.64. Expenditures in 1898, \$32,956.56 : premiums and gratuities paid, \$7,812.50 ; current running expenses, \$18,882.89 ; interest, \$2,164.17 ; other expenses, \$4,097. The society offered \$8,100 in premiums, awarded \$7,840.50 * in premiums and gratuities and paid \$7,812.50,* which went to 77 cities and towns. Three hundred and ninety-seven dollars went to 13 cities and towns outside the State. Two hundred and two † persons received premiums and 116 † gratuities. Under head of farms \$785 was awarded ; under head of farm and garden products \$6,717.75 was awarded. The society reports 738 members, — 682 males and 56 females. Ten farmers' institutes were held in Horticultural Hall, Boston : January 8, on "The business side of fruit culture ;" January 15, on "Horticulture in Holland : decoration in public parks, bulb growing, nursery stock at Boskoop ;" January 22, on "Originating new vegetables ;" January 29, on "Nuts and nut culture ;" February 12, on "Some new notions about old insects ;" February 19, on "Trees in streets and elsewhere ;" February 26, on "The national flower movement ;" March 12, on "The relation of our public schools to rural and urban life, and the value of nature studies in our system of public instruction ;" March 19, on "The resistance of plants to parasitic fungi ;" and March 26, on "Native ferns in New England."

MASSACHUSETTS SOCIETY FOR PROMOTING AGRICULTURE.

Incorporated 1792, Acts of 1792, chapter 33.

This society made no returns to the Board of Agriculture for the year 1898.

* Offered and awarded in 1897 ; paid in 1898.

† Not including school gardeners.

MIDDLESEX NORTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 315.

Originally raised by contribution, \$3,000; now has \$35,000 invested as a capital stock in real estate. Total assets, \$37,350.25: real estate, \$35,000; bank funds, \$900; crockery, tables, etc., \$350; bills due and unpaid, \$1,025; cash on hand, \$75.25. Total liabilities, \$9,126.10: premiums due and unpaid, \$76.10; outstanding bills, \$50; mortgages or like liabilities, \$9,000. Receipts in 1898, \$3,410.85: bounty, \$600; new members, \$16; other sources, \$2,794.85. Expenditures in 1898, \$4,388: premiums and gratuities paid, \$770; current running expenses, \$1,710; interest, \$405; other expenses, \$1,503. The society offered \$1,491.25 in premiums, awarded \$848.10 in premiums and gratuities and paid \$770, which went to 10 cities and towns. Two hundred and ninety-four persons received premiums and 63 gratuities. Under head of farm and pet stock \$394.25 was awarded; under field and garden crops \$11.50 was awarded; under farm and garden products \$324.45 was awarded; under dairy products \$5 was awarded; under domestic manufactures \$116.10 was awarded; under agricultural implements \$6 was awarded; under trotting \$410 was paid. The society reports 1,446 members, — 1,053 males and 393 females. Three farmers' institutes were held: at Chelmsford, January 6, on "Economic summer and winter feeds for milch cows;" at Tyngsborough, February 11, on "The Channel Islands and their agriculture;" and at Billerica, March 3, on "General fruit culture."

MIDDLESEX SOUTH AGRICULTURAL SOCIETY.

Incorporated 1854, Acts of 1854, chapter 84.

Originally raised by contribution, \$3,000; now has \$13,000 invested as a capital stock in real estate. Total assets, \$13,400: real estate \$13,000; crockery, tables, etc., \$200; bills due and unpaid, \$200. Total liabilities, \$7,993.81: premiums due and unpaid, \$169.70; outstanding bills, \$74.11; mortgages or like liabilities, \$7,750. Receipts in 1898, \$2,497.71: bounty, \$600; new members, \$61.41;

donations, \$90.70; other sources, \$1,445.60. Expenditures in 1898, \$2,342.14: premiums and gratuities paid, \$300.90; current running expenses, \$1,235.07; interest, \$442.75; other expenses, \$363.42. The society offered \$1,411.20 in premiums, awarded \$470.60 in premiums and gratuities and paid \$300.90, which went to 8 cities and towns. One hundred and seventeen persons received premiums and 22 gratuities. Under head of farms \$27 was awarded; under farm and pet stock \$211.35 was awarded; under field and garden crops \$11 was awarded; under farm and garden products \$94.75 was awarded; under dairy products \$6 was awarded; under domestic manufactures \$57.60 was awarded; under objects strictly agricultural, not specified, \$50 was awarded; under trotting \$615 was paid; under objects other than agricultural, not specified, \$13 was awarded. The society reports 557 members, — 354 males and 203 females. Three farmers' institutes were held: at Hudson, March 2, on "The reflections of a modern hayseed" and "What crops to raise for market;" at Sherborn, March 11, on "Animal structure, the foundation of purpose;" and at Framingham, December 22, on "Holstein cattle."

NANTUCKET AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 25.

Originally raised by contribution, \$3,500; now has \$3,200 invested as a capital stock in real estate. Total assets, \$3,804.92: real estate, \$3,200; bills due and unpaid, \$604.92. Total liabilities consist of outstanding bills to the amount of \$604.92. Receipts in 1898, \$584.75: bounty, \$569.75; new members, \$15. Expenditures in 1898, \$1,253.36: premiums and gratuities paid, \$605.50; current running expenses, \$647.86. The society offered \$1,265.50 in premiums, and awarded and paid \$605.50 in premiums and gratuities, which went to 1 town. Under head of farms \$12 was awarded; under head of farm and pet stock \$340 was awarded; under field and garden crops \$32.50 was awarded; under farm and garden products \$51.25 was awarded; under dairy products \$6.50 was awarded; under domestic manufactures \$49.25 was awarded; under trotting

\$75 was paid; under objects other than agricultural, not specified, \$38.25 was awarded. The society reports 558 members, — 219 males and 339 females. Three farmers' institutes were held at Nantucket: November 7, on farm topics; November 14, on "Our agricultural fair;" and December 28, on "Our native products."

OXFORD AGRICULTURAL SOCIETY.

Incorporated 1888, Acts of 1888, chapter 93.

Originally raised by contribution, \$4,400; now has \$8,291.75 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, \$8,291.75: real estate, \$7,650; crockery, tables, etc., \$200; cash on hand, \$441.75. Receipts in 1898, \$3,718.18: bounty, \$600; new members, \$44; donations, \$127.25; other sources, \$2,946.93. Expenditures in 1898, \$2,676.43: premiums paid, \$1,433; current running expenses, \$300; other expenses, \$943.43. The society offered \$1,800 in premiums, awarded \$1,479.25 and paid \$1,433, which went to 19 cities and towns. One hundred and fifteen dollars went to 3 cities and towns outside the State. One hundred and twenty-nine persons received premiums. Under head of farms \$43 was awarded; under farm and pet stock \$635 was awarded; under field and garden crops \$36.25 was awarded; under farm and garden products \$20.50 was awarded; under dairy products \$11 was awarded; under domestic manufactures \$36.50 was awarded; under trotting \$670 was paid; under objects other than agricultural, not specified, \$29 was awarded. The society reports 642 members, — 344 males and 298 females. Three farmers' institutes were held: at Auburn, January 29, on "The care, handling and marketing of milk" and "The care and management of the dairy farm for butter;" at Sutton, April 13, on "The great economic changes and the necessity of farmers being alert to grasp the situation" and "The agriculture of the Channel Islands;" and at Oxford, December 9, on "The agriculture of the east."

PLYMOUTH COUNTY AGRICULTURAL SOCIETY.

Incorporated as the Agricultural Society in the County of Plymouth 1819, Acts of 1819, chapter 2; name changed to Plymouth County Agricultural Society in 1870, Acts of 1870, chapter 251.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be \$9,550; now has \$35,200 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$35,382.25: real estate, \$35,000; crockery, tables, etc., \$200; bills due and unpaid, \$150; cash on hand, \$32.25. Total liabilities consist of mortgages or like liabilities to the amount of \$6,945. Receipts in 1898, \$4,735.61: bounty, \$600; donations, \$24.60; other sources, \$4,111.01. Expenditures in 1898, \$4,703.36: premiums and gratuities paid, \$2,937.21; current running expenses, \$633.27; other expenses, \$1,132.88. The society offered \$2,751.50 in premiums, awarded \$1,776.81 in premiums and gratuities and paid \$2,937.21, which went to 30 cities and towns. One hundred and twenty-five dollars went to 1 city outside the State. Two hundred and seventy-three persons received premiums and 5 gratuities. Under head of farms \$30 was awarded; under farm and pet stock \$492.50 was awarded; under field and garden crops \$10 was awarded; under farm and garden products \$120.55 was awarded; under dairy products \$15 was awarded; under domestic manufactures \$136.75 was awarded; under objects strictly agricultural, not specified, \$45 was awarded; under trotting \$1,100 was paid; under objects other than agricultural, not specified, \$62* was awarded. The society reports 1,495 members, — 860 males and 635 females. Four farmers' institutes were held: at Middleborough, February 11, on "The cultivation and marketing of fruit;" at Middleborough, March 11, on "Field crops, with special reference to potatoes;" at West Bridgewater, March 18, on "How to make New England agriculture more profitable;" and at Bridgewater, December 20, on "Practical poultry culture."

SPENCER FARMERS' AND MECHANICS' ASSOCIATION.

Incorporated 1888, Acts of 1888, chapter 87.

Originally raised by contribution, \$4,034.08; now has \$8,950 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$8,950: real estate, \$8,000; crockery, tables, etc., \$950. Total liabilities, \$755: outstanding bills, \$55; mortgages or like liabilities, \$700. Receipts in 1898, \$2,037.19: bounty, \$600; new members, \$5; donations, \$433; other sources, \$999.19. Expenditures in 1898, \$2,040.98: premiums and gratuities paid, \$1,084.72; interest, \$34.02; other expenses, \$922.24. The society offered \$2,000 in premiums, awarded \$1,100 in premiums and gratuities and paid \$1,084.72, which went to 21 cities and towns. Thirty-five dollars went to 1 town outside the State. One hundred and twenty persons received premiums and 5 gratuities. Under head of farms \$27 was awarded; under head of farm and pet stock \$544 was awarded; under field and garden crops \$50.50 was awarded; under farm and garden products \$86 was awarded; under dairy products \$9 was awarded; under domestic manufactures \$41.50 was awarded; under objects strictly agricultural, not specified, \$23 was awarded; under trotting \$275 was paid; under objects other than agricultural, not specified, \$18 was awarded.* Three farmers' institutes were held: at Spencer, January 20, on "Insect enemies of fruit and shade trees;" at Spencer, February 20, on "The horse's foot and its diseases;" and at North Brookfield, March 10, on "The alkaline test for acidity in milk" and "Animal structure, the foundation of purpose."

UNION AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 110.

Originally raised by contribution, \$4,447.23; now has \$9,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$9,250.73: real estate, \$8,000; crockery, tables, etc., \$1,000; cash on hand, \$250.73. Total liabilities, \$1,702.16: premiums due and unpaid,

* The membership reported in 1898 was 958.

\$52.16; mortgages or like liabilities, \$1,650. Receipts in 1898, \$2,736.37: bounty, \$600; new members, \$29; other sources, \$2,107.37. Expenditures in 1898, \$2,485.64: premiums and gratuities paid, \$1,322.17; current running expenses, \$938; interest, \$93.46; other expenses, \$132.01. The society offered \$2,113.55 in premiums, awarded \$1,374.33 in premiums and gratuities and paid \$1,322.17, which went to 24 cities and towns. Three dollars and seventy-five cents went to 3 cities and towns outside the State. One hundred and ninety-nine persons received premiums and 72 gratuities. Under head of farms \$5 was awarded; under farm and pet stock \$484.17 was awarded; under field and garden crops \$53.46 was awarded; under farm and garden products \$46.30 was awarded; under dairy products \$10.50 was awarded; under domestic manufactures \$107.10 was awarded; under agricultural implements \$6 was awarded; under objects strictly agricultural, not specified, \$62 was awarded; under trotting \$580 was paid; under objects other than agricultural, not specified, \$25.80 was awarded. The society reports 1,322 members, — 609 males and 713 females. Three farmers' institutes were held at Blandford: February 1, on "Fruits;" April 29, on "Forage crops;" and December 20, on "Silos as a help in dairying."

WEYMOUTH AGRICULTURAL AND INDUSTRIAL SOCIETY.

Incorporated 1891, Acts of 1891, chapter 77.

Amount originally raised by contribution had increased in 1891 to \$10,270; now has \$11,470 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$11,506.37: real estate, \$11,200; crockery, tables, etc., \$270; bills due and unpaid, \$20; cash on hand, \$16.37. Total liabilities, \$1,990: outstanding bills, \$40; mortgages or like liabilities, \$1,950. Receipts in 1898, \$5,371.30: bounty, \$600; other sources, \$4,771.30. Expenditures in 1898, \$4,374.21: premiums and gratuities paid (including trotting), \$1,399.85; current running expenses, \$150; interest, \$171; other expenses, \$2,653.36. The society offered \$1,203.80 in premiums, awarded \$782.05 in premiums and gratuities and paid \$759.85, which went to 19 cities and

towns. Under head of farm and pet stock \$423.50 was awarded; under field and garden crops \$14 was awarded; under farm and garden products \$154.55 was awarded; under dairy products \$3 was awarded; under domestic manufactures \$140.10 was awarded; under children's department \$10.30 was awarded; under objects other than agricultural, not specified, \$36.60 was awarded. The society reports 488 members, — 482 males and 6 females. Three farmers' institutes were held: at Weymouth, January 31, on "Milk and its production;" at North Weymouth, February 11, on "Poultry;" and at South Weymouth, August 25, on "Management of an agricultural fair."

WORCESTER AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 163.

The society in its first report to the Board in 1853 stated that the amount of its permanent fund (par value) was \$7,730; now has \$150,000 invested as a capital stock in real estate. Total assets, \$150,902.41: real estate, \$150,000; crockery, tables, etc., \$600; bills due and unpaid, \$70; cash on hand, \$232.41. Total liabilities, \$66,908.44: outstanding bills, \$5,908.44; mortgages or like liabilities, \$61,000. Receipts in 1898, \$4,237.18: bounty, \$600; notes, \$1,976.25; bank funds, \$3.87; new members, \$20; donations, \$124; other sources, \$1,513.06. Expenditures in 1898, \$2,356.76: premiums and gratuities paid, \$604; current running expenses, \$1,752.76. The society offered \$612.50 in premiums, and awarded and paid \$604, which went to 16 cities and towns. Seventy-two persons received premiums and 5 gratuities. Under head of farms \$15 was awarded; under farm and pet stock \$241 was awarded; under field and garden crops \$145 was awarded; under farm and garden products \$203 was awarded. The society reports 1,797 members, — 1,635 males and 162 females. Three farmers' institutes were held: at Worcester, January 20, on "The war against the gypsy moth" and "Rural economy;" at Holden, February 16, on "Economical feeds for dairy cows" and "Fertilizers *v.* stable manure;" and at Grafton, February 25, on "Following my wife's advice" and "Roads and roadside improvement."

WORCESTER EAST AGRICULTURAL SOCIETY.

Incorporated 1890, Acts of 1890, chapter 41.

Originally raised by contribution, \$2,296.23; now has \$5,730.84 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, \$5,730.84: real estate, \$4,104.40; bank funds, \$1,343.44; crockery, tables, etc., \$283. Receipts in 1898, \$4,640.50: bounty, \$600; bank funds, \$21.78; new members, \$27; donations, \$302; other sources, \$3,689.72. Expenditures in 1898, \$4,155.83: premiums and gratuities paid, \$1,246.50; current running expenses, \$2,909.33. The society offered about \$1,650 in premiums, awarded \$1,255 in premiums and gratuities and paid \$1,246.50, which went to 19 cities and towns. Four dollars went to 1 city outside the State. Two hundred and twenty-one persons received premiums and gratuities. Under head of farms \$23 was awarded; under farm and pet stock \$615.25 was awarded; under farm and garden products \$195 was awarded; under dairy products \$12 was awarded; under domestic manufactures \$96.25 was awarded; under agricultural implements \$14 was awarded; under trotting \$530 was paid; under coaching parade \$275 was paid; under objects strictly agricultural, not specified, \$56.50 was awarded. The society reports 672 members, — 441 males and 231 females. Three farmers' institutes were held: at Sterling, January 19, on "Fruit culture;" at Berlin, March 11, on "The home garden;" and at Bolton, March 25, on "How plants get their nitrogen."

WORCESTER NORTH-WEST AGRICULTURAL AND MECHANICAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 117.

Originally raised by contribution, \$3,400; now has \$12,600 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$12,600: real estate, \$12,000; crockery, tables, etc., \$600. Total liabilities consist of mortgages or like liabilities to the amount of \$3,418.74. Receipts in 1898, \$5,344.75: bounty, \$600; new members, \$30; other sources, \$4,714.75. Expenditures in 1898, \$5,447.79: premiums paid, \$2,287.47; current running expenses, \$2,973.89;

interest, \$186.43. The society offered \$3,043.75 in premiums, awarded \$2,324.30 and paid \$2,287.47, which went to 31 cities and towns. Six hundred and forty-four dollars and fifty cents went to 6 cities and towns outside the State. One hundred and seventy persons received premiums. Under head of farms \$23 was awarded; under farm and pet stock \$745.75 was awarded; under farm and garden products \$173.50 was awarded; under dairy products \$17 was awarded; under domestic manufactures \$36.55 was awarded; under agricultural implements \$9 was awarded; under trotting \$1,273.50 was paid; under objects other than agricultural, not specified, \$46 was awarded. The society reports 1,040 members,—667 males and 373 females. Four farmers' institutes were held: at North Orange, January 29, on "The fertility of the farm, and how to maintain it" and "Profitable means of increasing the hay crop;" at Petersham, February 23, on "How to feed the dairy cow for milk and cream production" and "Modern important dairy problems;" at Athol, March 11; and at Gardner, March 22.

WORCESTER SOUTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 278.

Originally raised by contribution, \$3,127.40; now has \$10,974 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$11,209.39: real estate, \$10,600; crockery, tables, etc., \$374; cash on hand, \$235.39. Total liabilities, \$2,682.40: premiums due and unpaid, \$43.50; outstanding bills, \$138.90; mortgages or like liabilities, \$2,500. Receipts in 1898, \$7,267.70: bounty, \$600; new members, \$58; donations, \$262.50; other sources, \$6,347.20. Expenditures in 1898, \$7,118.43: premiums and gratuities paid, \$2,025.66; current running expenses, \$1,497.72; interest, \$35; other expenses, \$3,560.05. The society offered \$2,450 in premiums, awarded \$2,025.66 in premiums and gratuities and paid \$1,982.16, which went to 24 cities and towns. One hundred and thirty persons received premiums and 73 gratuities. Under head of farms \$53 was awarded; under farm and pet stock \$846 was awarded; under farm and garden products \$128.73 was awarded; under

dairy products \$21 was awarded; under domestic manufactures \$50.93 was awarded; under agricultural implements \$24.50 was awarded; under objects strictly agricultural, not specified, \$78.75 was awarded; under trotting \$827.50 was paid; under objects other than agricultural, not specified, \$19.75 was awarded. The society reports 1,630 members, — 790 males and 840 females. Three farmers' institutes were held: at Sturbridge, January 20, on "Advantages of a grange to a farming community" and "Guernsey cattle;" at West Brookfield, February 18, on "The agricultural colleges, what they have done and are doing for the farmer," and "What is the matter with our agricultural fair?" and at Podunk, March 30, on "Poultry culture."

WORCESTER COUNTY WEST AGRICULTURAL SOCIETY.

Incorporated 1851, Acts of 1851, chapter 278.

Originally raised by contribution, \$3,175; now has \$13,600 invested as a capital stock in real estate, crockery, tables, etc. Total assets, \$13,819.74: real estate, \$12,600; crockery, tables, etc., \$1,000; cash on hand, \$219.74. Total liabilities consist of a note to the amount of \$400. Receipts in 1898, \$3,562.94: bounty, \$600; bank funds, \$115.27; new members, \$55; donations, \$39.74; other sources, \$2,752.93. Expenditures in 1898, \$3,396.20: premiums and gratuities paid, \$1,708.41; current running expenses, \$1,027.79; interest, \$60; other expenses, \$600. The society offered \$2,064.75 in premiums, awarded \$1,748 in premiums and gratuities and paid \$1,708.41, which went to 27 cities and towns. Eight dollars went to 1 town outside the State. One hundred and forty-two persons received premiums and 35 gratuities. Under head of farms \$28 was awarded; under farm and pet stock \$653.40 was awarded; under farm and garden products \$139.60 was awarded; under dairy products \$14 was awarded; under domestic manufactures \$40.15 was awarded; under trotting \$870 was paid; under objects other than agricultural, not specified, \$3 was awarded. The society reports 511 members, — 453 males and 58 females. Three farmers' institutes were

held: at Hubbardston, January 20, on "Mixed farming, its advantages;" at Barre, January 29, on "General fruit culture;" and at North Brookfield, March 10, on "Animal structure, the foundation of purpose."

Summary.

	1896.	1897.	1898.
Number of societies, ...	*36	*36	33
Amount held invested or well secured as a capital stock.	\$801,791 30	\$803,181 25	\$798,922 16
Assets of societies, ...	902,393 40	923,350 26	944,507 86
Liabilities of societies, ...	156,161 90	186,176 95	157,458 75
Receipts, ...	204,241 16	221,182 56	303,309 95
Expenditures, ...	192,603 32	218,335 95	158,521 16
Bounty received from State, ...	20,084 12	20,344 68	19,933 17
Current running expenses, ...	79,174 07	85,284 08	73,666 44
Amount of premiums offered, ...	87,494 75	79,503 80	68,377 80
Amount of premiums and gratuities awarded,	68,055 33	59,408 24	50,983 93
Amount of premiums and gratuities paid, .	65,839 68	57,606 49	49,430 57
Amount awarded under head of farms, . .	1,127 33	1,137 50	1,420 50
Amount awarded under head of farm and pet stock.	21,167 61	20,764 68	17,855 00
Amount awarded under head of field and garden crops.	995 59	1,065 75	1,157 71
Amount awarded under head of farm and garden products.	13,107 22	13,475 86	12,021 08
Amount awarded under head of dairy products.	668 50	578 25	349 00
Amount awarded under head of domestic manufactures.	3,986 86	3,778 15	3,576 52
Amount awarded under head of miscellaneous	4,722 50	3,710 21	3,703 77
Amount paid out for trotting, ...	31,263 90	24,893 42	19,365 75
Number of persons receiving premiums, .	7,666	7,242	7,110
Number of persons receiving gratuities, .	1,842	1,918	1,330
Total male membership of the societies, .	22,897	22,960	21,620
Total female membership of the societies, .	7,503	7,718	7,551
Total membership of the societies, . . .	30,400	30,678	29,171
Number of farmers' institutes held, . . .	128	125	118

* Two held no fair.

DIRECTORY

OF THE

AGRICULTURAL AND SIMILAR ORGANIZATIONS IN
THE STATE.

MARCH, 1899.

STATE BOARD OF AGRICULTURE, 1899.

Members ex Officio.

HIS EXCELLENCY ROGER WOLCOTT.

HIS HONOR W. M. CRANE.

HON. WM. M. OLIN, *Secretary of the Commonwealth.*

H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*

C. A. GOESSMANN, PH.D., LL.D., *Chemist of the Board.*

WM. R. SESSIONS, *Secretary of the Board to July 1, 1899.*

JAMES W. STOCKWELL, *Secretary of the Board from July 1, 1899.*

Members appointed by the Governor and Council.

	Term Expires
FRANCIS H. APPLETON of Lynnfield, ...	1900
DWIGHT A. HORTON of Northampton, ...	1901
JAMES S. GRINNELL of Greenfield, ...	1902

Members chosen by the Incorporated Societies.

<i>Amesbury and Salisbury (Agr'l and Hort'l), ...</i>	F. W. SARGENT of Amesbury, ...	1900
<i>Barnstable County, ...</i>	JOHN BURSLEY of West Barnstable, ...	1901
<i>Berkshire, ...</i>	WESLEY B. BARTON of Dalton, ...	1900
<i>Blackstone Valley, ...</i>	SAMUEL B. TAFT of Uxbridge, ...	1900
<i>Bristol County, ...</i>	E. M. THURSTON of Swansea (P. O. South Swansea), ...	1902
<i>Deerfield Valley, ...</i>	HENRY A. HOWARD of Colrain, ...	1902
<i>Eastern Hampden, ...</i>	O. P. ALLEN of Palmer, ...	1900
<i>Essex, ...</i>	JOHN M. DANFORTH of Lynnfield, ...	1902
<i>Franklin County, ...</i>	F. L. WHITMORE of Sunderland, ...	1901
<i>Hampshire, ...</i>	GEO. P. SMITH of Sunderland, ...	1901
<i>Hampshire, Franklin and Hampden, ...</i>	EDWARD E. WOOD of Northampton, ...	1900
<i>Highland, ...</i>	C. K. BREWSTER of Worthington, ...	1902
<i>Hillside, ...</i>	ALVAN BARRUS of Goshen (P. O. Lithia), ...	1902
<i>Hingham (Agr'l and Hort'l), ...</i>	EDMUND HERSEY of Hingham, ...	1900
<i>Hoosac Valley, ...</i>	N. B. BAKER of Savoy (P. O. Savoy Centre), ...	1900
<i>Housatonic, ...</i>	CHARLES B. BENEDICT of Egremont, ...	1900
<i>Manf'rs' Agr'l (No. Attleborough), ...</i>	OSCAR S. THAYER of Attleborough, ...	1900
<i>Marshfield (Agr'l and Hort'l), ...</i>	WALTON HALL of Marshfield, ...	1900
<i>Martha's Vineyard, ...</i>	EVERETT A. DAVIS of West Tisbury, ...	1901
<i>Massachusetts Horticultural, ...</i>	E. W. WOOD of West Newton, ...	1900
<i>Massachusetts Society for Promoting Agriculture, ...</i>	N. I. BOWDITCH of Framingham, ...	1900
<i>Middlesex North, ...</i>	JOSHUA CLARK of Tewksbury (P. O. Lowell), ...	1901
<i>Middlesex South, ...</i>	ISAAC DAMON of Wayland (P. O. Cochituate), ...	1902
<i>Nantucket, ...</i>	J. S. APPLETON of Nantucket, ...	1900
<i>Oxford, ...</i>	J. W. STOCKWELL of Sutton, ...	1901
<i>Plymouth County, ...</i>	AUGUSTUS PRATT of North Middleborough, ...	1902
<i>Spencer (Far's and Mech's Assoc'n), ...</i>	J. ELTON GREEN of Spencer, ...	1901
<i>Union (Agr'l and Hort'l), ...</i>	ALMON W. LLOYD of Blandford, ...	1901
<i>Weymouth (Agr'l and Ind'l), ...</i>	QUINCY L. REED of South Weymouth, ...	1900
<i>Worcester, ...</i>	J. LEWIS ELLSWORTH of Worcester, ...	1902
<i>Worcester East, ...</i>	W. A. KILBOURN of South Lancaster, ...	1900
<i>Worcester North-west (Agr'l and Mech'l), ...</i>	T. H. GOODSPEED of Athol (P. O. Athol Centre), ...	1901
<i>Worcester South, ...</i>	C. D. RICHARDSON of West Brookfield, ...	1901
<i>Worcester County West, ...</i>	CHAS. A. GLEASON of New Braintree, ...	1902

ORGANIZATION OF THE BOARD.

OFFICERS.

President, . . . HIS EXCELLENCY ROGER WOLCOTT, *ex Officio*.
1st Vice-President, . JAMES S. GRINNELL of Greenfield.
2d Vice-President, . ELIJAH W. WOOD of West Newton.
Secretary, . . . { WM. R. SESSIONS of Hampden, to July 1, 1899.
 { JAMES W. STOCKWELL of Sutton, from July 1, 1899.
 Office, Rooms 134-136, State House, Boston.

COMMITTEES.

Executive Committee.

Messrs. E. W. WOOD of West Newton.
 W. A. KILBOURN of South Lancaster.
 ISAAC DAMON of Wayland.
 D. A. HORTON of Northampton.
 JOHN BURSLEY of West Barnstable.
 EDMUND HERSEY of Hingham.
 FRANCIS H. APPLETON of Peabody.

Committee on Agricultural Societies.

Messrs. W. A. KILBOURN of South Lancaster.
 Q. L. REED of South Weymouth.
 O. P. ALLEN of Palmer.
 N. B. BAKER of Savoy.
 CHARLES A. GLEASON of New Braintree.

Committee on Domestic Animals and Sanitation.

Messrs. ISAAC DAMON of Wayland.
 OSCAR S. THAYER of Attleborough.
 JOSHUA CLARK of Tewksbury.
 F. L. WHITMORE of Sunderland.
 ALMON W. LLOYD of Blandford.
 HENRY A. HOWARD of Colrain.

Committee on Gypsy Moth, Insects and Birds.

Messrs. E. W. WOOD of West Newton.
 AUGUSTUS PRATT of North Middleborough.
 F. W. SARGENT of Amesbury.
 N. I. BOWDITCH of Framingham.
 J. M. DANFORTH of Lynnfield.

Committee on Dairy Bureau and Agricultural Products.

Messrs. D. A. HORTON of Northampton.
 J. L. ELLSWORTH of Worcester.
 C. D. RICHARDSON of West Brookfield.
 C. B. BENEDICT of Egremont.
 E. E. WOOD of Northampton.

Committee on Agricultural College and Education.

Messrs. JOHN BURSLEY of West Barnstable.
 C. K. BREWSTER of Worthington.
 WESLEY B. BARTON of Dalton.
 J. W. STOCKWELL of Sutton.
 GEO. P. SMITH of Sunderland.
 ALVAN BARRUS of Goshen.

Committee on Experiments and Station Work.

Messrs. EDMUND HERSEY of Hingham.
 WALTON HALL of Marshfield.
 J. S. GRINNELL of Greenfield.
 T. H. GOODSPEED of Athol.
 J. ELTON GREEN of Spencer.

Committee on Forestry, Roads and Roadside Improvements.

Messrs. FRANCIS H. APPLETON of Peabody.
 J. S. APPLETON of Nantucket.
 E. A. DAVIS of West Tisbury.
 SAMUEL B. TAFT of Uxbridge.
 EDWARD M. THURSTON of Swansea.

The Secretary is a member, *ex officio*, of each of the above committees.

DAIRY BUREAU.

Messrs. D. A. HORTON of Northampton, 1901, C. D. RICHARDSON of West Brookfield,
1901, J. LEWIS ELLSWORTH of Worcester, 1902, *appointed by the Governor.*

Secretary WM. R. SESSIONS,* *Executive Officer.* GEO. M. WHIT-

AKER of Boston, *Assistant Executive Officer, ap-*
pointed by the Governor, 1899.

SPECIALISTS.

By Election of the Board.

<i>Chemist,</i>	Dr. C. A. GOESSMANN, ...	Amherst.
<i>Entomologist,</i>	Prof. C. H. FERNALD, ...	Amherst.
<i>Botanist and Pomologist,</i>	Prof. S. T. MAYNARD, ...	Amherst.
<i>Veterinarian,</i>	Prof. JAMES B. PAIGE, ...	Amherst.
<i>Engineer,</i>	WM. WHEELER, ...	Concord.
<i>Ornithologist,</i>	E. H. FORBUSII, ...	Malden.

By Appointment of the Secretary.

Librarian, F. H. FOWLER, B.Sc., *First Clerk.*

* Secretary Stockwell after July 1, 1899.

MASSACHUSETTS AGRICULTURAL COLLEGE.

Location, Amherst, Hampshire County.

BOARD OF TRUSTEES.		Term expires
J. HOWE DEMOND of Northampton, ...		1900
ELMER D. HOWE of Marlborough, ...		1900
NATHANIEL I. BOWDITCH of Framingham, ...		1901
WILLIAM WHEELER of Concord, ...		1901
ELIJAH W. WOOD of West Newton, ...		1902
CHAS. A. GLEASON of New Braintree, ...		1902
SAMUEL C. DAMON of Lancaster, ...		1903
JAMES DRAPER of Worcester, ...		1903
HENRY S. HYDE of Springfield, ...		1904
MERRITT I. WHEELER of Great Barrington, ...		1904
JAMES S. GRINNELL of Greenfield, ...		1905
CHARLES L. FLINT of Brookline, ...		1905
WILLIAM H. BOWKER of Boston, ...		1906
J. D. W. FRENCH of North Andover, ...		1906

MEMBERS EX OFFICIO.

His Excellency Governor ROGER WOLCOTT,
President of the Corporation.

HENRY H. GOODELL, M.A., LL.D., ...	<i>President of the College.</i>
FRANK A. HILL, ...	<i>Secretary of the Board of Education.</i>
WILLIAM R. SESSIONS, ...	<i>Secretary of the Board of Agriculture.</i>

OFFICERS ELECTED BY THE BOARD OF TRUSTEES.

JAMES S. GRINNELL of Greenfield, ...	<i>Vice-President of the Corporation.</i>
WILLIAM R. SESSIONS of Hampden, ...	<i>Secretary.</i>
Prof. GEO. F. MILLS of Amherst, ...	<i>Treasurer.</i>
CHARLES A. GLEASON of New Braintree, ...	<i>Auditor.</i>

BOARD OF OVERSEERS.

The State Board of Agriculture.

EXAMINING COMMITTEE OF THE BOARD OF AGRICULTURE.

Messrs. BURSLEY, BREWSTER, BARTON, STOCKWELL, SMITH and BARRUS.

HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

HENRY H. GOODELL, M.A., LL.D., ...	<i>Director.</i>
WILLIAM P. BROOKS, B.Sc., ...	<i>Agriculturist.</i>
SAMUEL T. MAYNARD, B.Sc., ...	<i>Horticulturist.</i>
CHARLES H. FERNALD, Ph.D., ...	<i>Entomologist.</i>
CHAS. A. GOESSMANN, Ph.D., LL.D., ...	<i>Chemist (Fertilizers).</i>
JOSEPH B. LINDSEY, Ph.D., ...	<i>Chemist (Foods and Feeding).</i>
GEORGE E. STONE, Ph.D., ...	<i>Botanist.</i>
J. E. OSTRANDER, C.E., ...	<i>Meteorologist.</i>

BOARD OF CATTLE COMMISSIONERS.

		Term expires
AUSTIN PETERS, M.R.C.V.S., of Boston, <i>Chairman,</i>		1900
JOHN M. PARKER, V.S., of Haverhill, <i>Secretary,</i>		1899
L. F. HERRICK of Millbury, ...		1899
CHARLES A. DENNEN of Pepperell, ...		1900
MAURICE O'CONNELL, D.V.S., of Holyoke, ...		1902

Office, Commonwealth Building, Boston.

AGRICULTURAL SOCIETIES INCORPORATED BY SPECIAL ACT OF THE LEGISLATURE AND REPRESENTED ON THE BOARD OF AGRICULTURE.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Amesbury and Salisbury,*	C. W. Woods, Newbury.	A. H. Fielden, Amesbury.	J. E. Brerley, Amesbury.
Barnstable County,	C. M. Hinkle, Barnstable.	T. C. Day, Barnstable.	A. F. Sherman, Barnstable.
Berkshire,	M. W. Coleman, Richmond.	Chas. H. Wright, Pittsfield.	J. W. Lewis, Pittsfield.
Blackstone Valley,	James Daley, Uxbridge.	Edwin F. Tuttle, Uxbridge.	L. A. Seagrave, Uxbridge.
Bristol County,	N. J. W. Fish, Taunton.	Gertrude Williams, Taunton.	E. C. Holt, Taunton.
Deerfield Valley,	Chas. E. Ward, Packland.	S. W. Hawkes, Charlemont.	E. F. Huskins, Charlemont.
Eastern Hampden,	A. D. Norcross, Monson.	F. D. Barton, Palmer.	F. D. Barton, Palmer.
Essex,	Geo. von L. Meyer, Hamilton.	J. M. Dunforth, Lyndonfield Centre.	G. L. Streeter, Salem.
Franklin County,	A. A. Smith, Colrain.	Henry J. Field, Greenfield.	Henry J. Field, Greenfield.
Hampshire,	A. M. Lyman, Montague.	Edward Conkey, Amherst.	Edward Conkey, Amherst.
Hampshire, Franklin and Hampden,	H. C. Combs, Hadley.	S. S. Warner, Northampton.	D. J. Wright, Northampton.
Higland,	Wesley B. Barton, Dalton.	John T. Bryan, Middlefield.	M. J. Smith, Middlefield.
Hillside,	S. W. Clark, Cummington.	W. G. Atkins, West Cummington.	R. R. Packard, Cummington.
Hingham,*	E. L. Ripley, Hingham.	William H. Thomas, Hingham.	Reuben Sprague, Hingham.
Housac Valley,	Geo. Z. Dean, Cheshire.	Geo. F. Miller, North Adams.	E. M. Meekins, North Adams.
Housatonic,	E. H. Slater, Tyringham.	Frank H. Briggs, Great Barrington.	O. C. Bidwell, Great Barrington.
Manufacturers' Agricultural,	S. O. Bigney, Attleborough.	Wm. H. Pond, Attleborough.	W. W. Sherman, N. Attleborough.
Marshfield,*	H. A. Oakman, Marshfield.	Francis Collamore, N. Pembroke.	Francis Collamore, N. Pembroke.
Martha's Vineyard,	D. A. Cleaveland, West Tisbury.	B. T. Hillman, Edgartown.	Geo. H. Luce, West Tisbury.
Massachusetts Horticultural,	Francis H. Appleton, Peabody.	Robert Manning, Boston.	C. E. Richardson, Cambridge.
Massachusetts Society for Promoting Agriculture,	Chas. S. Sargent, Brookline.	Francis H. Appleton, Peabody.	J. C. Rogers, Boston.
Middlesex North,	H. J. Tolles, Dunstable.	E. T. Rowell, Lowell.	S. Drewett, Lowell.
Middlesex South,	S. O. Staples, South Framingham.	Geo. E. Harrington, S. Framingham.	Edgar Potter, South Framingham.
Nantucket,	Joseph A. Johnson, Nantucket.	J. F. Murpley, Nantucket.	Asa C. Jones, Nantucket.

* And Horticultural.

AGRICULTURAL SOCIETIES, ETC. — *Concluded.*

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Oxford, ...	John J. Allen, Auburn.	H. H. Sigourney, Oxford.	H. H. Sigourney, Oxford.
Plymouth County, ...	I. N. Nutter, East Bridgewater.	Geo. M. Hooper, Bridgewater.	R. C. Breck, Bridgewater.
Spencer (Farmers' and Mechanics' Association), ...	-	H. H. Capen, Spencer.	H. H. Capen, Spencer.
Union,*	Wm. H. Lewis, Blandford.	E. W. Bolse, Blandford.	A. H. Nye, Blandford.
Weymouth (Ag'l and Ind.), ...	E. B. Nevins, South Weymouth.	T. L. Tirrell, South Weymouth.	Gordon Willis, South Weymouth.
Worcester, ...	W. C. Jewett, Worcester.	L. F. Herrick, Worcester.	L. F. Herrick, Worcester.
Worcester East, ...	John E. Thayer, Lancaster.	W. A. Killbourn, South Lancaster.	Lucius Field, Clinton.
Worcester North-west (Agricultural and Mechanical), ...	A. F. Tyler, Athol.	J. F. Whitcomb, Athol Centre.	F. G. Amidsen, Athol.
Worcester South, ...	Walter B. Mellen, Brookfield.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West, ...	A. F. Adams, Barre Plains.	Matthew Walker, Barre.	Chas. H. Follansby, Barre.

* And Horticultural.

HORTICULTURAL SOCIETIES.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Cape Ann, ...	Gloucester, ...	Bennett Griffin, Gloucester.	William D. Lufkin, Gloucester.
Haverhill, ...	Haverhill, ...	Walter Goodrich, Haverhill.	Mrs. William M. Webster, Bradford.
Hamden County, ...	Springfield, ...	R. Hale Smith, Springfield.	William F. Gale, Springfield.
Houghton, ...	Lynn, ...	Walter B. Allen, Lynn.	Miss Ruth S. Wood, Lynn.
Hyde Park, ...	Hyde Park, ...	H. J. Stockford, Hyde Park.	J. R. Andrews, Hyde Park.
Lenox, ...	Lenox, ...	A. H. Wingett, Lenox.	H. P. Wokey, Lee.
Massachusetts, ...	Massachusetts, ...	Francis H. Appleton, Peabody.	Robert Manning, Boston.
Newton, ...	Newton, ...	L. H. Farlow, Newton.	L. H. Farlow, Newton.
Springfield Amateur, ...	Springfield, ...	W. T. Hutchins, Indian Orchard.	Chas. L. Burr, Springfield.
Worcester County, ...	Worcester County, ...	O. B. Hadwen, Worcester.	Adin A. Hixon, Worcester.

FARMERS' AND MECHANICS' ASSOCIATIONS.

Bolton, ...	Bolton, ...	Henry F. Haynes, Bolton.	Wm. M. Brigham, Bolton.
Leominster, ...	Leominster, ...	George M. Kendall, Leominster.	C. C. Foster, Leominster.
Middlesex and Worcester, ...	Hudson, ...	Oliver Sawyer, Hudson.	Josiah S. Welsh, Hudson.
Needham, ...	Needham, ...	William D. Rudd, South Natick.	Cyrus W. Jones, Needham.
Oakham, ...	Oakham, ...	H. A. Crawford, Oakham.	Wm. S. Crawford, Oakham.
Princeton, ...	Princeton, ...	J. E. F. Mireck, Princeton.	J. E. Merriam, Princeton.
Westminster, ...	Westminster, ...	E. C. Damon, Westminster.	Judson Foster, South Westminster.

FARMERS' AND MECHANICS' CLUBS.

Ashburnham, ...	Ashburnham, ...	E. J. Foristall, South Ashburnham.	Chas. F. Packard, Ashburnham.
Ashby, ...	Ashby, ...	W. O. Loveland, Ashby.	W. J. Smith, Ashby.
Belchertown, ...	Belchertown, ...	D. F. Shumway, Belchertown.	Geo. H. B. Green, Belchertown.
Berlin, ...	Berlin, ...	P. B. Southwick, Clinton.	J. D. Southwick, Berlin.
Groton, ...	Groton, ...	T. Lawrence Motley, Groton.	Charles Woolley, Groton.
Holden, ...	Holden, ...	Chas. T. Mead, Holden.	M. E. Hubbard, Holden.
Pepperell, ...	Pepperell, ...	A. N. Blood, Pepperell.	S. R. Merrill, Pepperell.
Shirley, ...	Shirley, ...	H. S. Hazen, Shirley.	-
Shrewsbury, ...	Shrewsbury, ...	E. A. Bartlett, Shrewsbury.	Fred J. Stone, Shrewsbury.
West Acton, ...	West Acton, ...	Isaac Reed, West Acton.	Chas. B. Stone, West Acton.
Wilmington, ...	Wilmington, ...	J. Howard Eames, Wilmington.	Edw. M. Nichols, Wilmington.

FARMERS' CLUBS.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Ashfield, ...	Ashfield, ...	John M. Sears, Ashfield.	A. G. Howes, Ashfield.
Boxborough, ...	Boxborough, ...	Frank A. Patch, West Acton.	J. F. Hayward, West Littleton.
Buckland, ...	Buckland, ...	F. H. Smith, Buckland.	E. C. Maynard, Buckland.
Chamberlain District, ...	Worcester, ...	Wm. J. Wheeler, Worcester.	S. A. Burgess, Worcester.
East Charlemont, ...	East Charlemont, ...	Horace Manning, East Charlemont.	Geo. H. Wheeler, East Charlemont.
Easthampton, ...	Easthampton, ...	E. H. Clark, Easthampton.	C. W. Smith, Easthampton.
Franklin, ...	Franklin, ...	Charles Badger, Franklin.	L. W. Daniels, Franklin.
Halifax, ...	Halifax, ...	Jabez P. Thompson, Halifax.	Mrs. George W. Hayward, Halifax.
Huntington, ...	Huntington, ...	C. H. Strong, Norwich.	H. W. Stickney, Norwich.
Lancaster, ...	Lancaster, ...	G. F. Morse, South Lancaster.	F. A. Hanaford, South Lancaster.
New Braintree, ...	New Braintree, ...	F. C. Barlow, Gilbertville.	C. P. McClanathan, Barre Plains.
New Salem, ...	New Salem, ...	D. F. Carpenter, Millington.	Willard Putnam, Cooleyville.
Practical, ...	Egremont, ...	Herman T. Potts, South Egremont.	Mrs. L. T. Osborne, Alford.
Rehoboth, ...	Rehoboth, ...	Dr. C. H. Raymond, Rehoboth.	C. W. Goff, South Rehoboth.
Rowley, ...	Rowley, ...	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
Royalston, ...	Royalston, ...	-	G. E. Pierce, Royalston.
Rutland, ...	Rutland, ...	E. H. Crosby, Rutland.	Mrs. W. G. Wales, Rutland.
South Bristol, ...	New Bedford, ...	Franklyn Howland, New Bedford.	Allen Russell, Acushet.
Sterling, ...	Sterling, ...	Joseph H. Kilburn, Sterling.	Ezra Sawyer, Sterling.
Tatnuck, ...	Worcester, ...	Elliott Moore, Worcester.	H. Ward Moore, Worcester.
Upton, ...	Upton, ...	Chas. A. Whitney, Upton.	P. W. Rockwood, Upton.
West Brookfield, ...	West Brookfield, ...	A. C. White, West Brookfield.	L. H. Chamberlain, West Brookfield.
West Newbury, ...	West Newbury, ...	Dr. A. H. Pierce, West Newbury.	A. L. Moore, West Newbury.
West Peabody, ...	West Peabody, ...	Mrs. F. C. Durkee, West Peabody.	Bertha G. Small, West Peabody.
Wilbraham, ...	Wilbraham, ...	B. F. Green, North Wilbraham.	H. M. Bliss, Wilbraham.

MISCELLANEOUS.

Agricultural Library Association, . . .	Swansea, . . .	S. G. Arnold, Swansea Village.	A. E. Arnold, Swansea Centre.
Boston Market Gardeners' Association, . . .	Boston and vicinity, . . .	W. W. Rawson, Arlington.	Wm. P. Eddy, Dighton.
Bristol Co. Fruit Growers' Association, . . .	Dighton, . . .	J. E. Sears, Dighton.	N. I. Bowditch, Framingham.
Bay State Agricultural Society, . . .	Boston, . . .	J. D. W. French, Boston.	Basil Sanford, Brockton.
Brockton Agricultural Society, . . .	Brockton, . . .	Henry W. Robinson, Brockton.	H. H. Nichols, Burlington.
Burlington Agricultural Society, . . .	Burlington, . . .	Fernald E. Ham, Lexington.	Franklin Crocker, Hyannis.
Cranberry Growers' Association, . . .	Cape Cod District, . . .	Emulous Small, Harwichport.	F. S. Thomas, M.D., Hanson.
Farmers' and Gardeners' Club, . . .	Hanson, . . .	George F. Simpson, Hanson.	C. B. Lyman, Southampton.
Franklin Harvest Club, . . .	Connecticut Valley, . . .	Thaddeus Graves, Hatfield.	E. S. Batchelder, Springfield.
Hampden Agricultural Society, . . .	Springfield, . . .	C. W. Benis, Longmeadow.	W. H. Porter, Agawam.
Hampden Harvest Club, . . .	Connecticut Valley, . . .	The members alternately.	S. T. Maynard, Amherst.
Massachusetts Fruit Growers' Association, . . .	The State, . . .	Geo. Cruickshanks, Fitchburg.	Charles Talbot, Montrose.
Middlesex East Agricultural Association, . . .	Wakefield, . . .	Frank P. Bennett, Saugus.	George M. Howe, Westborough.
Westborough Agricultural Society, . . .	Westborough, . . .	John B. Fitch, Westborough.	John H. White, Fitchburg.
Worcester North Agricultural Society, . . .	Fitchburg, . . .	J. L. Harrington, Lunenburg.	H. E. Miller, Ludlow.
Young Men's Harvest Club, . . .	Ludlow, . . .	Chas. B. Bennett, Ludlow.	J. W. Rice, Wilbraham.
Young People's Agricultural Club, . . .	Wilbraham, . . .	Walter M. Bliss, Wilbraham.	

MASSACHUSETTS PATRONS OF HUSBANDRY.

OFFICERS OF THE STATE GRANGE, 1899.

Master, ...	Warren C. Jewett of Worcester.
Overseer, ...	E. A. Emerson of Haverhill.
Lecturer, ...	George S. Ladd of Sturbridge.
Steward, ...	W. B. Barton of Dalton.
Assistant Steward, ...	J. B. Parkin of Holliston.
Chaplain, ...	Rev. C. S. Walker of Amherst.
Treasurer, ...	F. A. Harrington of Worcester.
Secretary, ...	Wm. N. Howard of South Easton.
Gate Keeper, ...	I. H. Lamb of Stoughton.
Pomona, ...	Mrs. Carrie C. Sabin of Amherst.
Flora, ...	Mrs. Emma S. Eaton of Fitchburg.
Ceres, ...	Miss Susie Wing of Littleton.
Lady Assistant Steward, ...	Mrs. S. Ella Southland of Athol.

EXECUTIVE COMMITTEE.

H. A. Barton, ...	Dalton.
C. A. Dennen, ...	Pepperell.
Geo. L. Clemence, ...	Southbridge.

DEPUTIES.

Marcellus Boynton, ...	Shawmut.
T. E. Flarity, ...	Townsend.
Herbert Sabin, ...	Amherst.
F. H. Stevens, ...	West Acton.
C. D. Richardson, ...	West Brookfield.
Charles G. Hinckley, ...	Lee.
Edward A. Fuller, ...	North Andover.
I. N. Day, ...	South Hadley.
John E. Gifford, ...	Sutton.
C. A. Stimson, ...	Royalston.
J. E. Goodell, ...	West Boylston.
George W. Roraback, ...	Westfield.
Charles H. Rice, ...	Leominster.
H. F. Maxwell, ...	Canton.
Rev. A. H. Wheelock, ...	Millis.

SPECIAL DEPUTIES.

Wm. N. Howard, ...	South Easton.
F. H. Plumb, ...	Springfield.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
<i>Pomona Granges.</i>			
Middlesex and Norfolk, No. 1, . . .	Henry W. Hosmer, Mills.	Abel F. Stevens, Wellesley.	Mrs. Nellie S. Stevens, Wellesley.
Essex County, No. 2, . . .	George E. Crosby, Tewksbury.	Benjamin J. Bulch, Topsfield.	Matilda B. Lund, West Boxford.
Middlesex and Worcester, No. 3, . . .	Chas. F. Watts, Littleton Common.	Mrs. Lizzie E. Starr, Peppewell.	Mrs. Annie E. Robbins, Lowell.
Franklin and Worcester, No. 4, . . .	James F. Whitcomb, Athol Centre.	Edward S. Young, Orange.	Luther E. Stewart, Athol.
Worcester West, No. 5, . . .	Chas. W. Whitney, Ashburnham.	J. Harry Allen, Hubbardston.	Chas. W. Snow, Nichevaug.
Berkshire County, No. 6, . . .	Alonzo Bradley, Lee.	J. S. Cole, Hinsdale.	Blanche Barton, Dalton.
Worcester Central, No. 7, . . .	John E. Gifford, Sutton.	S. A. Burgess, Worcester.	Mrs. Ellen M. Hayward, Millbury.
Hampshire County, No. 8, . . .	Wallace A. Mann, Northampton.	Rev. E. C. Winslow, Amherst.	Miss Alice Dickinson, Amherst.
Worcester Southwest, No. 9, . . .	Melvin Shepard, Sturbridge.	Mrs. Mary Olds Lakin, Brookfield.	Mrs. A. J. Thompson, Brookfield.
Worcester and Norfolk, No. 10, . . .	Wm. P. Greenwood, South Milford.	Mrs. Wm. P. Greenwood, S. Milford.	John E. Hollis, Uxbridge.
Borough, No. 11, . . .	H. A. Wheeler, Berlin.	Mrs. Mary C. Graham, Westborough.	Mrs. Mary S. Wood, Northborough.
Springfield, No. 12, . . .	W. S. Clark, Granby.	Mrs. E. E. Chapman, Ludlow.	Mrs. C. L. Hayward, Agawam.
Old Colony, No. 13, . . .	Ernest H. Gilbert, Stoughton.	H. F. Maxwell, Canton.	Mrs. Geo. W. Stevens, South Braintree.
Worcester East, No. 14, . . .	E. T. Cunningham, Lancaster.	Mrs. J. G. Warner, Boylston Centre.	Mrs. E. T. Cunningham, Lancaster.
Quabaug, No. 15, . . .	Wm. E. Patrick, Warren.	A. C. Stoddard, North Brookfield.	Andrew A. Brigham, Brookfield.
<i>Subordinate Granges.</i>			
Northfield, No. 3, . . .	T. R. Calendar, Northfield.	Elsie L. Saunders, Northfield.	II. H. Mason, Northfield.
Groton, No. 7, . . .	Henry M. Adams, Groton.	Albert F. Sargent, Groton.	Mrs. Olive M. Wilson, Groton.
Barre, No. 9, . . .	James A. Dwyne, Barre.	Mrs. C. H. Osgood, Barre.	Thomas P. Blakeley, Barre.
"Hope" of Hadley, No. 15, . . .	Leslie R. Smith, Hadley.	Mrs. H. E. Smith, Hadley.	Mrs. Chas. L. Hartwell, South Amherst.
Amherst, No. 16, . . .	David R. Whipple, Amherst.	Mrs. C. S. Walker, Amherst.	Miss Alice F. Dickinson, Amherst.
Hinsdale, No. 19, . . .	Thomas F. Barker, Hinsdale.	Mrs. F. F. Watkins, Hinsdale.	John S. Cole, Hinsdale.
Westfield, No. 20, . . .	C. E. Robinson, Westfield.	Chas. M. Gardner, Westfield.	Annette Sackett, Westfield.
Worcester, No. 22, . . .	A. H. Bellows, Worcester.	Wm. K. Stanley, Worcester.	Mrs. A. E. Grout, Worcester.
Dalton, No. 23, . . .	Edward R. Morse, Dalton.	Henry N. French, Pittsfield.	W. H. Woodworth, Dalton.
Blandford, No. 24, . . .	Geo. S. Wood, Blandford.	Mrs. Geo. S. Wood, Blandford.	E. J. Wyman, Blandford.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Easthampton, No. 27, ...	W. M. Gaylord, Easthampton.	Mrs. A. L. Pettis, Easthampton.	Ethel Locke, Easthampton.
Middlefield, No. 33, ...	L. O. Moore, Montgomery.	D. L. Allyn, Montgomery.	Agnes E. Moore, Montgomery.
Montgomery, No. 45, ...	Amasa Holcomb, Southwick.	Wm. F. Fletcher, Southwick.	Mrs. Chas. G. Stone, Southwick.
Southwick, No. 46, ...	H. R. Gooch, Huntington.	Mrs. E. D. Cady, Huntington.	J. W. Culver, Huntington.
"Highland" of Huntington, No. 48, ...	Joseph H. Kilburn, Sterling.	Mrs. E. E. Pesco, Pratts Junction.	R. W. Melendy, Sterling Junction.
Sterling, No. 53, ...	F. O. Taylor, Springfield.	F. H. Plumb, Springfield.	Miss Lillian V. Lee, Springfield.
Springfield, No. 54, ...	Geo. M. Allen, Auburn.	Mrs. W. H. Stockwell, West Millbury.	J. H. Prouty, Auburn.
Auburn, No. 60, ...	E. S. Lane, Belchertown.	Arthur E. Pease, Belchertown.	Mrs. D. P. Spencer, Belchertown.
"Union" of Belchertown, No. 64, ...	George W. Sherman, Brimfield.	Mrs. W. J. Easter, Brimfield.	Everett Sherman, Brimfield.
Brimfield, No. 65, ...	Charles Prouty, Furnace.	J. N. Hillman, Hardwick.	George Prouty, Furnace.
Hardwick, No. 67, ...	Wm. L. Wheeler, Templeton.	J. W. Moore, Templeton.	Mima B. Hager, Templeton.
Phillipston, No. 70, ...	H. C. Gray, Pepperell.	Mrs. L. E. Starr, Pepperell.	Frank Marston, Pepperell.
"Prescott" of Pepperell, No. 73, ...	Chas. B. Jordan, Holden.	Irving A. Dunn, Holden.	Mrs. Irving A. Dunn, Holden.
Holden, No. 78, ...	Herbert E. Jones, Spencer.	Mrs. Ida L. Warren, Spencer.	J. W. Bigelow, Spencer.
Spencer, No. 79, ...	Chas. S. Hooker, West Holyoke.	J. S. Fray, Southampton.	Mrs. C. P. Gridley, Southampton.
"Manhan" of Southampton, No. 82, ...	M. D. Herrick, North Orange.	C. H. Williston, North Orange.	Martha A. Cheney, North Orange.
North Orange, No. 86, ...	C. H. Shaylor, Lee.	J. E. Seacord, Lee.	C. O. Swift, Lee.
Lee, No. 88, ...	Geo. R. Taylor, Charlton.	Alice L. King, Charlton.	A. R. Jones, Charlton.
Charlton, No. 92, ...	Harris G. Stowe, Grafton.	Nelle J. Sinclair, Westborough.	E. S. Clark, Jr., Grafton.
Grafton, No. 93, ...	A. B. Cook, Petersham.	H. H. Lindsey, Petersham.	M. E. Prouty, Petersham.
Petersham, No. 95, ...	George E. Brigham, Shrewsbury.	David B. Rice, Shrewsbury.	Anne S. Rice, Shrewsbury.
Shrewsbury, No. 101, ...	William H. Clark, Stow.	Miss Emma Brown, Stow.	Mrs. U. M. Lewis, Stow.
Stow, No. 103, ...	J. E. Doubleday, North Dana.	E. A. Albee, North Dana.	Mrs. W. T. Childs, North Dana.
"Garfield" of North Dana, No. 104, ...	Joseph Walker, Marlborough.	Elmer D. Howe, Marlborough.	Mrs. E. N. Stratton, Marlborough.
Marlborough, No. 105, ...	John M. Smith, West Boylston.	Miss Ella L. Sawyer, West Boylston.	Fred B. Walker, West Boylston.
West Boylston, No. 106, ...			

Millbury, No. 107, . . .	G. I. Stowe, West Millbury.	Mabel R. Searles, Millbury.	C. H. Stockwell, West Millbury.
Hudson, No. 108, . . .	L. W. Bruce, Hudson.	Ellen A. Lamson, Hudson.	Mary E. Hall, Hudson.
Sutton, No. 109, . . .	R. H. Richardson, Sutton.	J. W. Stockwell, Sutton.	Sarah M. Mills, Sutton.
Sherborn, No. 110, . . .	D. L. Whitney, South Framingham.	N. B. Douglas, Sherborn.	Mrs. Geo. L. Whitney, So. Framingham.
Boylston, No. 111, . . .	Wm. H. Warner, Boylston Centre.	Miss Lydia P. Warner, Boylston Centre.	Mrs. H. M. Andrews, Boylston Centre.
"East Medway" of Mills, No. 112, . . .	W. W. Whitling, Millis.	W. P. Clark, Rockville.	Louis La Croix, Millis.
Framingham, No. 113, . . .	L. M. Marston, Framingham.	Grace Adams, Framingham.	Lila Warren, Framingham.
Medfield, No. 114, . . .	J. Herbert Baker, Medfield.	Amos H. Mason, Medfield.	Mrs. W. W. Preston, Medfield.
Holliston, No. 115, . . .	Miss Mary E. Cutler, Hudson.	Mrs. Carrie A. Pond, Holliston.	Henry Leland, Holliston.
Westborough, No. 116, . . .	Chas. Jones, Southville.	Lyman C. Hicks, Westborough.	Ella C. B. Leonard, Westborough.
Dover, No. 117, . . .	Chester Hanebett, Jr., Dover.	Miss Eva Chamberlain, Dedham.	Mrs. S. A. Higgins, Dover.
Southborough, No. 118, . . .	C. B. Savin, Southborough.	P. S. Lincoln, Southville.	Mrs. M. A. Klebes, Southborough.
Northborough, No. 119, . . .	J. K. Mills, Northborough.	Mrs. Mary L. Richardson, Northborough.	Mrs. Mary S. Wood, Northborough.
Lancaster, No. 120, . . .	W. A. Kilbourn, South Lancaster.	Anna G. Currier, Clinton.	H. Eliza Currier, Clinton.
Sudbury, No. 121, . . .	J. S. Rice, North Sudbury.	F. F. Walker, South Sudbury.	Fred A. Noyes, Sudbury.
Templeton, No. 122, . . .	Genery Stiles, Baldwinville.	George French, South Gardner.	Geo. H. Hawkes, Templeton.
Oxford, No. 123, . . .	L. H. Cudworth, Oxford.	Eva C. Tufts, Oxford.	Josie A. Tyler, Oxford.
Ashland, No. 124, . . .	Chas. P. Rockwood, Ashland.	Mrs. H. D. Stone, Ashland.	Miss Bertha M. Stone, Ashland.
Upton, No. 125, . . .	Wm. Harper, Upton.	Mrs. Gertrude Aldrich, West Upton.	L. Jennie Chapman, West Upton.
Hubbardston, No. 126, . . .	Chas. C. Colby, Hubbardston.	J. Harry Allen, Hubbardston.	Mrs. Annie M. Leach, Hubbardston.
Amesbury, No. 127, . . .	Geo. E. Battis, Amesbury.	J. Augustus Davis, Amesbury.	Nellie A. Huntington, Amesbury.
North Andover, No. 128, . . .	M. B. Meserve, North Andover.	Albert Currier, N. Andover Depot.	W. H. Hayes, N. Andover Depot.
Gardner, No. 130, . . .	Hamlin A. Whitney, South Gardner.	Laura E. Barnes, West Gardner.	Ada G. Hobby, Gardner.
Boxborough, No. 131, . . .	Levi W. Perkins, West Acton.	Luede C. Hager, West Acton.	E. A. Furbush, West Acton.
North Brookfield, No. 132, . . .	H. E. Cummings, North Brookfield.	Mrs. Frances Cummings, N. Brookfield.	Minnie McCarthy, North Brookfield.
Berlin, No. 134, . . .	W. A. Hartshorn, Berlin.	Mrs. L. W. Brewer, Berlin.	Mrs. Fannie A. Jones, South Berlin.
Norfolk, No. 135, . . .	Arthur D. Towne, City Mills.	Geo. P. Holbrook, Norfolk.	Sarah B. Sims, Norfolk.
East Blackstone, No. 137, . . .	O. F. Fuller, Blackstone.	Mrs. Addie Stearnes, Blackstone.	Adrian Scott, Blackstone.
Northampton, No. 138, . . .	W. A. Mann, Northampton.	Clayton S. Parsons, Northampton.	Miss Sarah E. Mason, Northampton.
East Sandwich, No. 139, . . .	Mrs. R. S. Armstrong, East Sandwich.	Geo. Parker, East Sandwich.	J. F. Carleton, East Sandwich.
West Boxford, No. 140, . . .	Chas. M. Moulton, South Groveland.	Mrs. Olivia K. Anderson, W. Boxford.	Matilda B. Lund, West Boxford.
Montague, No. 141, . . .	F. A. Dean, Montague.	Miss Bessie E. Sheldon, Montague.	F. A. Rist, Montague.
Bolton, No. 142, . . .	Alfred R. Buckman, Bolton.	Clara S. Walcott, Bolton.	Dorcas H. Babcock, Bolton.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Mendon, No. 143, . . .	J. Newton Nutt, Mendon.	Leonard E. Taft, Mendon.	Albert W. Gaskill, Mendon.
Franklin, No. 144, . . .	John L. Fisher, City Mills.	Mrs. John L. Fisher, City Mills.	Julia W. Allen, Franklin.
Douglas, No. 145, . . .	Arthur E. Rawson, East Douglas.	Mrs. Sarah E. Brown, East Douglas.	Fred A. Peace, East Douglas.
West Newbury, No. 146, . . .	William H. Swap, West Newbury.	Mrs. L. M. Newell, West Newbury.	Mrs. Annie Swap, West Newbury.
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ELEVENTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1899.

BOSTON :
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1899.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are: —

HENRY H. GOODELL, LL.D.,
 WILLIAM P. BROOKS, Ph.D.,
 GEORGE E. STONE, Ph.D.,
 CHARLES A. GOESSMANN, Ph.D., LL.D.,
 JOSEPH B. LINDSEY, Ph.D.,
 CHARLES H. FERNALD, Ph.D.,
 SAMUEL T. MAYNARD, B.Sc.,
 J. E. OSTRANDER, C.E.,
 HENRY M. THOMSON, B.Sc.,
 RALPH E. SMITH, B.Sc.,
 HENRI D. HASKINS, B.Sc.,
 CHARLES I. GOESSMANN, B.Sc.,
 SAMUEL W. WILEY, B.Sc.,
 EDWARD B. HOLLAND, M.Sc.,
 FRED W. MOSSMAN, B.Sc.,
 BENJAMIN K. JONES, B.Sc.,
 PHILIP H. SMITH, B.Sc.,
 ROBERT A. COOLEY, B.Sc.,
 GEORGE A. DREW, B.Sc.,
 HERBERT D. HEMENWAY, B.Sc.,
 ARTHUR C. MONAHAN,

Director.
Agriculturist.
Botanist.
Chemist (fertilizers).
Chemist (foods and feeding).
Entomologist.
Horticulturist.
Meteorologist.
Assistant Agriculturist.
Assistant Botanist.
Assistant Chemist (fertilizers).
Assistant Chemist (fertilizers).
Assistant Chemist (fertilizers).
First Chemist (foods and feeding).
Assistant Chemist (foods and feeding).
Assistant Chemist (foods and feeding).
Assistant in Foods and Feeding.
Assistant Entomologist.
Assistant Horticulturist.
Assistant Horticulturist.
Observer.

The co-operation and assistance of farmers, fruit growers, horticulturists and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the "Hatch Experiment Station, Amherst, Mass."

The following bulletins are still in stock and can be furnished on demand:—

- No. 27. Tuberculosis in college herd; tuberculin in diagnosis; bovine rabies; poisoning by nitrate of soda.
- No. 33. Glossary of fodder terms.
- No. 35. Agricultural value of bone meal.
- No. 37. Report on fruits, insecticides and fungicides.
- No. 41. On the use of tuberculin (translated from Dr. Bang).
- No. 42. Fertilizer analyses; fertilizer laws.
- No. 43. Effects of electricity on germination of seeds.
- No. 45. Commercial fertilizers; fertilizer analyses; fertilizer laws.
- No. 46. Habits, food and economic value of the American toad.
- No. 47. Field experiments with tobacco.
- No. 48. Fertilizer analyses.
- No. 49. Fertilizer analyses.
- No. 50. The feeding value of salt-marsh hay.
- No. 51. Fertilizer analyses.
- No. 52. Variety tests of fruits; spraying calendar.
- No. 53. Concentrated feed stuffs.
- No. 54. Fertilizer analyses.
- No. 55. Nematode worms.
- No. 56. Concentrated feed stuffs.
- No. 57. Fertilizer analyses.
- Special bulletin, — The brown-tail moth.
- Index, 1888-95.

Of the other bulletins, a few copies remain, which can only be supplied to complete sets for libraries.

New methods and new appliances in the feeding and care of animals and plants have opened up new problems, and the demands made upon the station have taxed it to its uttermost. Briefly summarizing the work of the year, we find it distributed as follows: in the division of foods and feeding a new feature has been added, viz., regulating the sale of concentrated feed stuffs. There have been 663

analyses of these materials made, 292 of fodder and 420 of dairy products. In an investigation of Cleveland flax meal *v.* old-process linseed meal for feeding early lambs, it was found that no injurious results followed from the use of flax meal, and that there was the same average daily growth of the lambs on either ration; in an experiment of corn meal *v.* hominy meal and corn meal *v.* cerealine feed for growing pigs, it was found that the corn meal was five to ten per cent. more valuable than cerealine feed used in connection with skim-milk, while hominy meal was quite as valuable as corn meal in connection with skim-milk.

In the entomological division, besides the special work in connection with the gypsy moth, attention has been paid to combining the arsenate of lead and the Bordeaux mixture, with favorable results. The life histories and habits of two pernicious insects have been worked out,—the grass thrips, particularly destructive in this State, and the small clover-leaf beetle (*Phytonomus nigrirostris*). The pernicious scale insects (*Chionaspis*) have also been carefully studied, and the results will soon be published.

The horticultural division has continued its work of testing varieties of fruits, domestic and foreign, suitable for this State, and its investigation of hydrocyanic acid as an insecticide.

The division of fertilizers has made five hundred and fifty-two analyses; has conducted experiments on the use of concentrated chemical manures to supply plant food in greenhouses, combinations of high-grade fertilizers for garden, greenhouse and pot cultivation; and has made observations with dried blood and two kinds of leather refuse as a source of nitrogen for growing rye in presence of acid and alkaline phosphates.

The agricultural division, in addition to its soil tests with corn, onions, oats, etc., has undertaken the testing of seeds of the same variety of potatoes raised in different localities, finding a variation of fifty per cent. in Early Rose and Beauty of Hebron. In experiments with poultry the following results were obtained with reference to egg production: (*a*) that condition powders had no effect; (*b*) that

animal meal was of more value than cut bone; (c) that the influence of the cock was *nil*; (d) that a wide ration was preferable to a narrow ration.

The botanical division has issued an illustrated bulletin (No. 55) on the nematode worm, in which its life history is traced, and a simple remedy, steaming the soil, given for its repression. Work has been done in the drop and top burn of lettuce, asparagus and chrysanthemum rust, and in sub-irrigation and the mechanical condition of soil as affecting the growth of lettuce.

Reports from the different divisions, giving in detail the work of the year, accompany this brief summary.

ANNUAL REPORT

OF GEORGE F. MILLS, *Treasurer* OF THE HATCH EXPERIMENT STATION
OF MASSACHUSETTS AGRICULTURAL COLLEGE,

For the Year ending June 30, 1898.

Cash received from United States treasurer, ...	\$15,000 00
Cash paid for salaries, ...	\$4,443 00
for labor, ...	3,605 36
for publications, ...	2,885 54
for postage and stationery, ...	235 56
for freight and express, ...	355 49
for heat, light and water, ...	130 17
for seeds, plants and sundry supplies, ...	448 72
for fertilizers, ...	285 86
for feeding stuffs, ...	141 17
for library, ...	244 78
for tools, implements and machinery, ...	250 00
for furniture and fixtures, ...	105 19
for scientific apparatus, ...	228 36
for live stock, ...	901 00
for traveling expenses, ...	220 00
for contingent expenses, ...	80 65
for building and repairs, ...	439 15
	<u>\$15,000 00</u>
Cash on hand July 1, 1897, ...	\$19 73
Received from State treasurer, ...	11,200 00
from fertilizer fees, ...	3,278 75
from farm products, ...	1,763 86
from miscellaneous sources, ...	1,663 45
	<u>\$17,925 79</u>
Cash paid for salaries, ...	\$8,901 77
for labor, ...	3,167 18
for publications, ...	708 27
for postage and stationery, ...	236 16
for freight and express, ...	154 97
<i>Amount carried forward, ...</i>	<u>\$13,168 35</u>

<i>Amount brought forward,</i>	. . .	\$13,168 35
Cash paid for heat, light and water,	. . .	549 44
for chemical supplies,	. . .	958 54
for seeds, plants and sundry supplies,	. . .	368 02
for feeding stuffs,	. . .	592 46
for library,	. . .	191 10
for tools, implements and machinery,	. . .	34 49
for furniture and fixtures,	. . .	40 23
for scientific apparatus,	. . .	187 11
for live stock,	. . .	313 50
for traveling expenses,	. . .	356 73
for contingent expenses,	. . .	163 96
for building and repairs,	. . .	1,001 86
		\$17,925 79

I, Charles A. Gleason, duly appointed auditor of the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1898; that I have found the books well kept and the accounts correctly classified as above; and that the receipts for the year are shown to be \$32,925.79, and the corresponding disbursements \$32,925.79. All the proper vouchers are on file, and have been by me examined and found to be correct, there being no balance on accounts of the fiscal year ending June 30, 1898.

CHARLES A. GLEASON,
Auditor.

AMHERST, Aug. 31, 1898.

REPORT OF THE METEOROLOGIST.

JOHN E. OSTRANDER.

During the year, as in previous years, the meteorological division has been principally engaged in the observations of the various weather elements and phenomena, and the compilation of the records in permanent form. The more important results, together with summaries of most of the others, have been published, as heretofore, in bulletin form each month. The usual summary of the weather for the year will be issued when the records are completed.

The records of the division were begun with the year 1889; accordingly, this year completes the first decennial period. A tabulation of the results for the whole period is under way, for use in determining the means of the several weather elements at this station. These results should give normal conditions differing but little from those that may afterward be deduced from observations covering a much longer time, and will be found valuable for the purpose of determining departures from mean conditions in the future. The tables are being arranged in a suitable form for publication, so that they may be issued in bulletin form, if it is thought desirable.

While the self-recording instruments in the tower give generally good results, the records of the sun thermometer are lacking in precision. Cold-air currents and variable wind velocities give at times records which cannot be distinguished from those due to cloudiness. The desirability of having a photographic or an electrical sunshine recorder, for use in conjunction with the Draper instrument, is suggested.

The local forecasts of the weather have been received daily, except Sunday, from the Boston office of the United

States Weather Bureau, and the signals displayed on the top of the tower. At the request of Mr. J. W. Smith, director of the New England section of the United States Weather Bureau, this division has arranged to furnish his office the weekly snow reports, as has been done the past few years. The record of the number of days of sleighing, begun by Professor Metcalf, is being continued.

During the year attempts were made to secure some records of atmospheric electricity by using the quadrant electrometer in the tower, but without success. The extreme sensitiveness of the instrument seems to preclude its working at any such height from the ground, where it is necessarily subjected to the vibrations of the building. Unless a suitable location and mounting can be provided elsewhere, the records it was intended to secure cannot be obtained with any degree of success.

During the year the division purchased one of the resistance boxes made after the design of Prof. Milton Whitney, of the Division of Soils, United States Department of Agriculture, for the purpose of continuing the examination of soil moisture by the electrical method. The electrodes could not be obtained from the manufacturer until early in June, and then a number proved defective. Others were loaned us later by the Department at Washington for continuing the work. The results obtained have been even less satisfactory than those of last year. An examination of the electrodes in the soil showed in some cases short circuits to have been produced by the growth of roots across the face; in other cases no cause could be found for unusual changes in the resistance. A continuation of the experiment another year may perhaps furnish more satisfactory results, or reveal the causes of some abnormal fluctuations.

REPORT OF THE HORTICULTURIST.

SAMUEL T. MAYNARD.

The work of this division during the past year has been carried on in about the same lines as for the year of 1897.

Of the experiments conducted, variety testing of fruits, vegetables, flowers, etc., has occupied considerable attention. This work has been undertaken largely in response to the constant calls from the people to know the value of widely advertised new varieties put upon the market with extravagant claims of merit and at exorbitant prices, nine-tenths or perhaps ninety-nine-hundredths of which prove of less value than the old established sorts.

FRUIT INVESTIGATIONS.

The Apple.

With each succeeding year the fact is more and more clear that old varieties, from the many conditions of cultivation, from increased injury by insects and fungous pests, grow more feeble and are more and more subject to the continued action of the above agencies; and that new varieties must be found, that can be more easily and cheaply grown, or that will meet the demand for fruit of better quality. The Baldwin apple, for so long a time the most profitable and satisfactory variety for market, has in many places in the last two or three years shown so great a tendency to the dry-rot spots under the skin, long before its normal time for the breaking down of its tissues in the process of ripening, that much of its fruit put on the market has had the effect of decreasing the demand and lowering the price; while the Ben Davis, not nearly as good in quality, but firm, fresh and solid from skin to core, has been sold in our local markets to the exclusion of the home product.

The varieties of apples tested here and in many other sections, that stand out prominently as possessing those qualities that will enable them to successfully compete with the winter varieties shipped to our markets from other States, are the Sutton Beauty, Palmer, MacIntosh Red, Wealthy and Gano.

Sutton Beauty. — Much superior in quality to the Baldwin; is of similar color, perhaps not quite as large unless thinned, and has not shown the dry-rot spots so common in the latter variety. The tree is vigorous and compact in growth, generally with strong, healthy foliage, and so prolific as to require thinning. For local trade it is one of the best.

Palmer. — An apple of medium to large size, of a golden-yellow color when grown on trees in the full exposure of sunlight, but of a green color if grown on closely planted trees. It is of the best quality, tender, crisp and rich. Being an apple of light color and tender flesh, it should be handled very carefully when gathered, and sold in bushel boxes, in which it will not be subjected to much pressure or jolting.

MacIntosh Red. — This is one of the most beautiful of late fall and early winter apples, and, as far as it has been tested in Massachusetts, has done well, and promises to secure much of the trade for fancy apples that demands such varieties as the Fameuse, or Snow apple, which is not successfully grown in this State.

Wealthy. — Generally this variety has proved very satisfactory, but has only been grown on young trees. Its season of ripening is when there is an abundance of fall apples, but it often keeps into early winter. It colors up early, and its beauty, together with its fine quality and somewhat elastic texture, not easily bruised, makes it a good market variety, and should make it valuable as an early shipping apple with which to open the fall trade in European markets, which in the past has been greatly injured by shipping half-ripe and poorly colored Baldwins, and other varieties not as well colored or matured as the latter variety. It has thus far proved prolific, an early bearer and free from disease, but will be greatly improved by thinning.

Ben Davis.—It has been stated on good authority that more of this variety were sold in the Boston markets and on fruit stands during the winter of 1897 than of any other kind, almost the entire amount of which were imported from the western States. In quality and beauty this apple is far below any of the varieties above mentioned; yet its perfect form, uniform size, good keeping qualities, and its very firm, but somewhat elastic flesh, render it less affected by handling and shipping than almost any variety in cultivation. It is very productive, but, as grown in New England, unless thinned, will be of medium or small size. From its behavior thus far it would seem that, if a variety of so poor quality is to be demanded by our markets, it may be grown quite as successfully in many sections of the State as in any other section of the country. This, however, is not necessary; for, if the previously named varieties are well grown, there will be no difficulty in securing the local markets for them, if they are properly sorted and delivered.

Gano.—This variety was introduced as an improved Ben Davis, and, as far as tested, has proved superior to that variety in color, and perhaps to a very slight degree in quality. As yet it has only been produced on young trees, so that its real value cannot be determined without many years' further trial.

Pears.

With the large number of kinds of choice fruit that is now competing with the fruit grown in New England, the pear seems to be less in demand than formerly. Fewer varieties also are found profitable than a few years ago. Of those that stand at the head of the list, the Bartlett, Bose, Sheldon, Seckle and Hovey are the most generally grown and bring the highest prices.

Peaches.

The interest in peach growing in this State seems on the increase, and the growers are coming to see that it is useless to plant the peach for profit except on high land, where a moderately vigorous growth can be maintained, and

where the temperature is such that the fruit buds mature more fully and are not so liable to be destroyed by extreme cold. The varieties that are popular in the market and that are most profitably and successfully grown are Crawford's Early, Crawford's Late, Old Mixon, Elberta and Crosby. All of these varieties except the Elberta have long been grown in Massachusetts. The latter is an oval peach of large size and of a light-yellow color, with more or less color on the exposed side. It is generally hardy and productive, but the past season, in a great many sections of this and other States, was so seriously injured by the "leaf curl" as to endanger its vitality. Should it continue to be attacked by this disease, it will not long remain a profitable variety.

Plums.

Many growers of this fruit in the State have become discouraged from the lack of profit in the domestic plum, on account of the black knot, plum curculio, leaf blight and brown rot. The results obtained in the station orchards give no reason for such discouragement. Trees of all ages, from thirty years old to those of one or two years' growth, may be found, and almost every variety of any value is represented. Upon these trees will be found hardly a knot to the tree. No leaf blight appeared on the majority of the trees, and many varieties matured their fruit with little or no injury from the brown rot, while a few others were seriously injured. In the average season the use of the Bordeaux mixture, as recommended in the spraying calendar in Bulletin 52, has been found to prevent even the serious injury of the fruit by the brown rot; and the past season, had one or two applications of the copper sulphate solution (one-fourth pound to fifty gallons of water) been made the last of July or in early August, this loss might have been greatly reduced. The black knot has almost wholly succumbed to the treatment outlined in the bulletin mentioned, and the most healthy and vigorous foliage is to be found upon all the trees. The varieties that show the greatest tendency to rot are Lombard, Washington, Gueii, Smith's Orleans and Victoria. Those that show the least are Brad-

shaw, Prince Englebert, Kingston, Grand Duke, Reine Claude and Felleberg. The amount of rotting of many varieties, however, is largely dependent upon the weather at the time of their approaching maturity, and only prompt and frequent spraying at this time will save the crop.

Of the newer varieties, those that show the most promise are the Kingston, Lincoln and Felleberg.

Kingston. — Fruit very large, oval in form, slightly pointed at both ends, of the brightest blue color, firm in texture and very acid in quality; ripens late in the season and hangs a considerable time on the tree; very productive and valuable for canning, though it is rather large for this purpose.

Lincoln. — Early, dark purple, of large size and very fine quality; fruited but two years in the station orchards, but it seems very promising.

Felleberg. — This seems identical with a variety that we have had growing for nearly thirty years under the name of the German prune. It is a regular biennial bearer, but never produces large crops. The fruit is of medium to large size, tapering at both ends. It is of deep purple color, a perfect freestone and of very good quality. Its great value lies in its long keeping and its fine canning qualities.

The Japanese plums, from their rapid growth, great productiveness, early bearing and attractiveness, are being quite largely planted in nearly all sections of the country, and promise to be of considerable value to our fruit growers who do not succeed in growing the domestic varieties. The trees seem to be a little less subject to the black knot and the brown rot, but more subject to the shot-hole fungus, and are often seriously injured by the use of the copper solution and the arsenites. The fruit is attractive, and meets a ready sale; but whether the demand will be large enough to keep up with the increased planting that is going on, time only can determine. All of the varieties of reported value have been planted in the station orchard, forty-eight in all, many of which will fruit next summer for the first time, unless the fruit buds are destroyed by the

cold winter weather. In some cases these varieties are attacked by some disease similar to the peach yellows. Of the varieties that have been tested for several years in various sections of the country, the Abundance, Burbank, Red June and Satsuma have proved satisfactory. Of the newer varieties that are of very fine quality the Wickson, Hale and October Purple may be mentioned.

The Satsuma has not ripened here so as to be of much value for table use, but from the deep-red color of its flesh it is especially valuable for canning. It seems to be weak in self-fertilizing qualities, and needs to be planted among other varieties for the best results in pollination.

Cherries.

The crop of cherries in the station orchard would have been unusually large but for the extremely hot and moist weather at the time of ripening, which caused the fruit to rot badly. The trees had been regularly sprayed with Bordeaux up to the time when it would disfigure the fruit, but there was not a sufficient quantity of the copper from this to spread over the rapidly growing leaves and fruit. From results obtained here and from reports received from other stations, it is probable that spraying thoroughly *immediately* after each rain, as the fruit begins to color, with the copper solution (four ounces of copper sulphate to fifty gallons of water), would largely prevent this loss. It is urged that the coming season those engaged in growing cherries should try this treatment. It must be borne in mind that the application should be made very soon after the rain ceases, as the spores of the brown rot germinate very quickly when placed in moisture, and it is to prevent this germination that the application is made. Heavy rains, especially if soon followed by dry weather, need be little feared, as they tend to wash the spores off the plants, though some may gain a lodgement in the axils of the leaves or in the calyx of the fruit or other places. The varieties most satisfactory were Governor Wood, Napoleon, Black Tartarian and Early Richmond.

Grapes.

Perhaps upon no fruit crop grown in New England is the certainty of protection by spraying so great as with the grape crop, when properly done, and upon which insecticides and fungicides are so easily and cheaply applied. Campbell's Early, the only new variety fruiting that stands out as decidedly promising, produced fruit on several young vines. The growth of vine was satisfactory, the foliage free from disease, the fruit beautiful in appearance and of good quality. The compactness of bunch and firmness of berry will make it a good shipping grape, and, if it does not develop a tendency to disease, it will be a valuable addition to the few varieties that can be profitably grown in New England. It ripens as early or perhaps a little before Moore's Early, and is much superior in quality. The varieties recommended for this section are Winchell or Green Mountain, Worden and Delaware.

Currants.

There is scarcely another fruit the merits of whose new varieties it is so difficult to decide as the currant, because of its great variation in size and productiveness under different conditions. All the new varieties of any prominence have been planted in the station plots, and those that stand out prominently as possessing merit are the Pomona, Wilder and the Red Cross; and, after three years fruiting, their value seems to be in the order given. The Pomona may be mentioned as of especial value, because of its superior quality. We have no records, however, to show that any of the above varieties will be more valuable for general cultivation than Fay's Prolific or the Cherry.

Blackberries.

All of the prominent new varieties have been added to the list under trial, but none have thus far shown themselves to be more valuable than the best older sorts, — the Agawam, Snyder and Taylor's Prolific. On heavy soils, where the growth is large and furnishes an abundant soil

cover, thus keeping the ground cool, the first-named variety proves very satisfactory; but when grown on light land it is of much less value.

The Eldorado continues to do well, and compares favorably with the above-mentioned varieties; but whether it will prove more valuable than any other, can only be determined in large plantation.

Raspberries.

With the red raspberry there has been little or no progress made in improved varieties. The Loudon, which, from its stocky growth, hardiness and fruit of good size, color and quality, seemed very promising, has the past season shown a tendency to mildew of the leaves and young growing canes. If this becomes general, it will greatly reduce its value. The seedlings produced from the seeds of the Shaffer, and referred to in a previous bulletin, have again fruited, and many of them show decided merit, some producing fruit of a bright scarlet color upon plants that propagate only from the tip of the cane, as does the Shaffer; while others produce fruit of the Shaffer type that propagate from suckers, like the common red raspberry.

Strawberries.

The past season was favorable for a large crop of fruit, but the extremely wet weather at the time of ripening caused much loss by rotting. The named varieties were planted in plots of twenty-five plants each, while the most promising of these are planted each season in rows under field culture. Of the varieties in plots (soil medium heavy loam), the Brandywine, Gandy Bell, Glen Mary, Sample and Howard's No. 14 gave the best results. Of those grown under field culture, on light land, the Clyde, Cumberland, Glen Mary, Howard's Nos. 36 and 41 gave the best results.

New Fruits.

Several new species of raspberries, the strawberry-raspberry, Logan-berry, Salmon-berry, May-berry, etc., have been planted, some of which have fruited, but only two seem to possess any merit for this climate. The straw-

berry-raspberry is an herbaceous perennial, the top of which dies to the ground in the winter, but is followed by numerous shoots in the spring from underground stems, that bear most beautiful wine-colored fruit in abundance. This fruit is of a peculiar, insipid, though not unpleasant flavor, and may be the origin of new varieties with a more decidedly pleasant taste. Should such varieties be produced, and a system of cultivation be worked out by which a reasonably certain crop can be secured, it may prove a valuable addition to our list of hardy fruits.

The Logan berry resembles the common dewberry or running blackberry in habit of growth and form of fruit; but the latter is rather larger, and of a dark-red or mahogany color. It possesses a pleasant flavor, but the same obstacle to its general cultivation is met as with the dewberry, — that it is difficult to devise a method of cultivation and training that will give a large crop of fruit every year.

REPORT OF THE CHEMIST.

DIVISION OF FOODS AND FEEDING.

J. B. LINDSEY.

Assistants, E. B. HOLLAND, F. W. MOSSMAN, B. K. JONES, P. H. SMITH, Jr.

PART I.—LABORATORY WORK.

Outline of Year's Work.

PART II.—FEEDING EXPERIMENTS AND DAIRY STUDIES.

PART I.

EXTENT OF CHEMICAL WORK.

The laboratory work connected with this department has been much increased during the past year. We have received for examination 159 samples of water, 228 samples of milk, 17 samples of butter, 4 samples of oleomargarine and 81 samples of feed stuffs. The work in connection with this and other divisions of the Station has consisted of the analysis of 394 samples of milk, 26 samples of butter, 292 samples of fodders and 11 miscellaneous samples. In addition to the above, we have collected 754 samples of feed stuffs under the provisions of the feed law, of which 663 samples have been examined. This makes a total of 1,875 substances analyzed, as against 1,147 in 1897. There have also been carried on for the Association of Official Agri-

cultural Chemists, investigations relative to the best methods for the determination of potash, and of the different ingredients in cattle foods, as well as a study of the most desirable methods to be employed in the estimation of sugar. It is hardly possible to express numerically the extent of this work.

CHARACTER OF CHEMICAL WORK.

Water. — We have followed the same general line of investigation as in former years, in the examination of waters sent by farmers and others.

Whenever possible printed instructions are sent for sampling and sending the water. In making a report to the party, a printed form is used. Upon the form there is explained the meaning of the terms used, so that every one will have at least a general idea of what the analytical results are meant to convey.

Those sending the samples have been advised promptly whether in our judgment the water was suitable for drinking and general domestic purposes. Whenever necessary, suggestions have been offered with the hope of improving the family supply. We again caution everyone who depends upon wells and springs for their drinking water to have all sink drains, etc., remote from the well, and to keep the ground in the vicinity free from objectionable matter. Lead pipes should never be used in drawing water from wells.

Milk. — Some of the milk sent to the station has been from farmers who ship their milk to the Boston market, and having been notified by the contractors that their article was below the legal standard, wished to ascertain if such was the fact, and if so, what could be done for its improvement. To such we have given the same advice as appeared in our last annual report, to which interested parties are referred.

Many farmers are now sending occasional samples of milk, cream and skim-milk to the station, to ascertain the amount of butter fat contained in them. These producers sell their milk to creameries, and they are desirous of knowing its quality for butter production. This is a

very encouraging sign, for it shows that the farmer really wishes to know the butter-producing capacity of his cows, and the efficiency of his separator, or Cooley creamer, in removing the fat from his milk. To all who desire, printed information is given, stating how to ascertain the yearly butter capacity of dairy cows.

Much of the milk and butter analyzed in connection with our own experiments has been studied with a great deal of care. We have estimated the water, solids, fat, casein, milk sugar, and ash in a large number of samples. We have also made a very thorough examination of 26 samples of butter fat produced by cows employed in connection with our feeding experiments. There have been determined in duplicates or triplicates, volatile acids, specific gravity, melting point, and the iodine number.

Cattle Feeds. — Our feed law has now been in operation about one and one-half years. We have made frequent inspections covering the entire State, and have published two especially prepared bulletins giving the results of our investigations. We have endeavored to make these bulletins as practical as possible, and judging from the way in which the bulletins are received, it is believed that we have in a measure succeeded. During the spring of 1898 a considerable quantity of adulterated cotton-seed meal was found in various sections of the State. Printed slips of warning were immediately sent to 100 newspapers in the State, and a concise circular was also mailed to every grain dealer, cautioning against its purchase. While meal of this character generally has a darker appearance than the prime article, samples of inferior meal have recently been found having quite a bright yellow color. A number of reputable manufacturers now print a guaranty upon every package, and purchasers are strongly advised to buy only the guaranteed article. The effect of the feed law has been to call the attention of all manufacturers to the necessity of branding their products, and having them run as even as possible in composition. Many of the more reputable manufacturers are now placing a guaranty upon their feeds, and it is hoped others will soon follow.

Many new feeds are constantly being offered for sale in our markets. A number have appeared during the year 1898. Our object is to secure samples of these materials promptly, and ascertain their feeding and comparative commercial values. For detailed information the reader is referred to Bulletins 53 and 56.

Other Chemical Work. — The analyses of feed stuffs and manures in connection with the numerous digestion experiments carried on by this division, involves a considerable amount of time and effort, but because of this work we are enabled to state with a reasonable degree of accuracy the feeding and commercial values of the concentrated feeds sold upon the market, and of the coarse feeds produced upon our farms.

It is the object of this division to assist the Association of Official Agricultural Chemists as much as possible in perfecting methods of chemical analyses, and in finding out methods for the estimation of the quantity and nutritive value of several of the newer carbohydrates. We spend whatever time can be had during each year in working along these lines, believing it will be productive of much good in the future. During the past year we have given attention to the estimation of pentosans, starch and sugar in agricultural plants.

The chemical work received from the agricultural division has very much increased during the past year. This work consists of the determination of dry matter in a large number of plants, the estimation of starch in potatoes, the analyses of feed stuffs used in poultry experiments, and in general fodder analyses. This increased work is now severely taxing the resources of our chemical force.

PART II.

A. CLEVELAND FLAX MEAL *v.* OLD-PROCESS LINSEED MEAL FOR EARLY LAMBS.*Object of the Experiment.*

It has recently been claimed, by parties who grow early lambs for market, that the so-called new-process linseed meal (Cleveland flax meal) exerted an injurious effect upon the young lamb. Some claim that this meal did not favor growth, and others that it was the cause of frequent sudden deaths. On the other hand, it was stated that the old-process meal did not have these injurious effects, but favored rapid growth and fattening. The station was asked to throw some light on the subject, and conducted the following experiment in the winter and early spring of 1898.

The Experiment.

Six grade Southdown ewes were brought to the station barn the first week in February, and each placed in a separate pen six feet wide by fifteen feet long. The pens were separated by stout wire netting, thus enabling the animals to see each other. The ewes were all in fair condition, and in about two weeks' time began to drop their lambs. Each lamb was weighed five days after being dropped.

Daily Feed for the Ewes after Lambing. — Two pounds corn ensilage, rowen *ad libitum*, 1 pound grain mixture. The grain mixture* was gradually increased until each ewe received $2\frac{1}{2}$ pounds daily. This grain feed was kept up as long as the ewes would take it, and was then gradually reduced. The grain mixture, as will be noticed, contained about one-third of one of the two kinds of linseed meal.

Daily Feed for the Lambs. — The pens were so arranged that the lambs gained access to a separate compartment, containing a mixture of grains. They soon learned to go in as soon as the feed was placed in the troughs. It was our aim

* The grain mixture consisted of 7.5 pounds of old-process linseed or flax meal, 7.5 pounds of bran, 5 pounds corn meal and 5 pounds gluten feed.

to feed them what they would eat daily: grain mixture No. 1, 7.5 pounds flax meal or old-process linseed meal, 7.5 pounds bran, 10 pounds corn meal.

After feeding this mixture for about two weeks, a second was fed, as follows: 10 pounds flax meal or old-process linseed meal, 5 pounds bran, 5 pounds corn meal.

When the lambs each reached 40 pounds in weight, the mixture was again changed to: one-third flax meal or old-process linseed meal, one-third bran, one-third corn meal.

It was our object to give the lambs as much of each of the two linseed meals as they would stand, and keep in a healthy, growing condition.

Care of the Lambs.—The lambs were kept in the pens with the ewes. As the season advanced, they were allowed the run of a large yard in the warmer part of sunny days.

RECORD OF GROWTH.

Flax Meal Lambs.

NUMBER OF LAMB.	Date Five Days after dropping.	Date when slaughtered.	No. of Days in Experiment.	Weight Five Days after dropping (Pounds).	Weight when slaughtered (Pounds).	Total Gain (Pounds).	Daily Gain (Pounds).
Lamb No. 8, . .	March 3,	May 5,	62	15.25	67.00	51.75	.83
Lamb No. 6, . .	March 1,	May 18,	78	10.25	57.50	47.25	.62
Lamb No. 7, . .	March 1,	May 25,	85	10.50	53.00	42.50	.50
Lamb No. 1, . .	February 25,	May 18,	82	9.50	47.50	38.00	.46
Lamb No. 2, . .	February 25,	May 25,	89	9.25	41.00	31.75	.36
Average, . .	-	-	79	10.95	53.20	42.25	.54

Old-process Linseed Meal Lambs.

Lamb No. 5, . .	February 25,	April 29,	63	11.75	52.25	40.50	.64
Lamb No. 3, . .	February 25,	May 18,	82	11.00	50.00	39.00	.48
Lamb No. 4, . .	February 25,	May 25,	89	8.75	44.50	35.75	.40
Lamb No. 9, . .	March 19,	June 1,	74	10.25	52.25	42.00	.57
Lamb No. 10, . .	March 19,	June 1,	74	9.00	51.00	42.00	.57
Average, . .	-	-	76	10.15	50.00	39.85	.53

NOTE.—Lambs 6 and 7, 1 and 2, 3 and 4, 9 and 10, were twins.

The lambs were shipped to Ira C. Lowe of Greenfield, Mass., who slaughtered them, and reported on their condition. He had no knowledge as to which lambs were fed the flax meal and which lambs were fed the old-process linseed meal ration. Lamb No. 8 was reported to be of extra quality, Lamb No. 5 next in quality to No. 8, and the others of fair quality only. Looking at the average figures in the above tables, it will be seen that each lot of five lambs showed the *same daily gain*. Mr. Lowe noticed no particular advantage in favor of either lot.

Results of the Experiment.

As a result of our observations, we conclude:—

That the flax meal had no injurious effect either upon the growth or dressed appearance of the lambs, and that both sets of lambs produced the same average daily growth, and were both in the same average condition when slaughtered.

Remarks and Suggestions.

It is well known to all growers of early lambs, that in order to secure a rapid growth of the lamb, the ewe should be thrifty, and a good milker. A liberal feeding will aid in keeping up a continuous flow of milk. The early growth of the lamb will depend very much on the constitution it inherits, and upon its success in obtaining a large supply of milk. Easily digested nitrogenous feed stuffs will unquestionably assist in producing quick growth, but they are secondary to the milk supply. This is quite forcibly illustrated in case of our experiments as described above. Lamb No. 8 was single, and its mother was an excellent milker. The lamb was above the average in size and vigor when dropped. He grew rapidly, showing .83 of a pound gain per day. It was noticed that this lamb did not consume very large amounts of grain, although he had a constant opportunity. He derived the larger part of the food necessary for his growth from his mother. Lamb No. 5 was also a single lamb. He made a very good growth, but the ewe was not as good a milker as the previous one. This lamb took more grain than did No. 8, but was not able to make as

rapid growth. The other lambs were twins. They did not grow as rapidly as did the single lambs, because of the lack of milk, although they ate quite freely of the grain mixtures. Lambs Nos. 6 and 7 came from a good milker, and they were also quite vigorous and hearty eaters.

In addition to inherited constitution and plenty of milk, it is very essential, in order to secure rapidity of growth, that early lambs should be housed in a warm, dry barn, and have a maximum amount of sunlight from a southern exposure.

B. CORN MEAL *v.* HOMINY MEAL, AND CORN MEAL *v.* CEREALINE FEED FOR GROWING PIGS.

Experiment I. — Corn meal *v.* hominy meal.

Experiment II. — Corn meal *v.* cerealine feed.

Experiment III. — Corn meal *v.* cerealine feed.

Objects of the Experiments.

Skim-milk is a very valuable feed for growing pigs. It is a digestible, nitrogenous feed stuff. Of itself it is not a complete food, being deficient in solid matter as well as in carbohydrates (starchy material). In order to make a complete food, carbohydrate feeds are necessary to properly balance the daily ration. A combination of skim-milk and corn meal (1 quart milk and from 3 to 6 ounces of meal) has been found to make a most excellent feed for rapid growth. The object of the above-mentioned experiments was to get at the feeding values of hominy meal and cerealine feed, when compared with corn meal, for this purpose.

What Hominy Meal is. — Hominy meal consists of the hulls, germ and some of the starch and gluten of the corn, ground together. This separation is said to be brought about solely by the aid of machinery. The hard, flinty part of the corn is the hominy, which is used as a human food.

What Cerealine Feed is. — This feed consists also of the hull and a portion of the starch of the corn. It contains rather less of the starch than does the hominy meal. It is

the by-product resulting from the preparation of the breakfast preparation known as cerealine flakes. It is very coarse looking, and appears much like unground corn hulls.

Results of Experiments.

1. Hominy meal produced 5 to 7 per cent. more growth, when fed to pigs in connection with skim-milk, than did corn meal. This difference was probably due to the dryer condition of the hominy meal, and nearly disappears when the meals are compared on a basis of dry matter they contained.

2. In view of the fact that Pig IV. was thrown out of the experiment, we should hesitate to say that the hominy meal had proved itself in any degree superior to the corn meal. This experiment would seem to indicate, however, that pound for pound, as found in the market, the hominy meal is at least fully as valuable as the corn meal.

3. In the two experiments with cerealine feed and corn meal, the corn meal produced 5 per cent. more growth than did the cerealine feed. Corn meal constituted but 62 per cent. of the dry matter of the ration; and, if 62 per cent. of dry matter of the ration in the form of corn meal produced a gain of 5 per cent., 100 per cent. of corn meal — *e. g.*, its full effect — would show an 8 per cent. gain.

4. We think we are justified in saying that corn meal is from 5 to possibly 10 per cent. more valuable than cerealine feed for use in connection with skim-milk for growing pigs.

5. Cerealine feed might prove equal to corn meal as a feed for milch cows, as digestion experiments with sheep have shown it to contain as much digestible matter as corn meal. It is very probable that pigs are not able to digest the hulls of the corn as well as other animals.

6. Because of the important part played by the individuality of the animal, we are frank to confess that a larger number of pigs would be desirable in conducting experiments of this kind. We feel confident, however, that these experiments give a fairly accurate representation of the comparative values of the several feed stuffs.

Experiment I. —Corn Meal v. Hominy Meal.

Nov. 23, 1896, to March 1, 1897 (98 Days). — Eight grade Chester White pigs, all of the same litter, were purchased in October. They were first fed skim-milk alone, and finally divided into two lots, and corn or hominy meal added to the skim-milk diet. Pigs Nos. I. and II. were together in one pen, and so were pigs Nos. VII. and VIII.; the others were in separate pens. Pig IV. was taken sick during the experiment, and his record is not considered. Each pig was allowed from 7 to 10 quarts of skim-milk daily, and from 3 to 6 ounces of grain for each quart of milk, the quantity depending on the appetite and stage of growth of the animals. As the pigs advanced in age and growth, the quantity of grain was increased, thus furnishing an increased food supply and an increasing amount of carbohydrates.

TOTAL FEEDS CONSUMED.

Corn Meal Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).
Pig No. V., ...	884.00	1,927.12	183.08	255.44	223.25
Pig No. VI., ...	883.00	1,924.94	182.87	255.44	223.25
Pigs Nos. VII. and VIII., .	1,766.00	3,849.88	365.74	510.88	446.50
Totals, ...	3,533.00	7,701.94	731.69	1,021.76	893.00
Averages, ...	883.25	1,925.49	182.92	255.44	223.25

Hominy Meal Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Hominy Meal (Pounds).	Dry Matter (Pounds).
Pigs Nos. I. and II., . . .	1,768.00	3,854.24	366.15	255.06	470.23
Pig No. III., ...	883.00	1,924.94	182.87	255.44	235.46
Totals, ...	2,651.00	5,779.18	549.02	765.56	705.69
Averages, ...	883.67	1,926.39	183.01	255.19	235.23

The above tables show that each lot of pigs consumed identical amounts of skim-milk, and very nearly equal amounts of grain. The hominy meal lot ate about 12 pounds more of dry grain per pig, than did the corn meal lot.

TOTAL GAIN IN LIVE WEIGHT.

Corn Meal Lot.

NUMBER OF PIG.	Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).
Pig No. V., ...	54.50	184.25	129.75	1.32
Pig No. VI., ...	58.25	167.00	130.25	1.33
Pigs Nos. VII. and VIII., . . .	109.25	{ 188.50 } { 185.25 }	243.00	2.48
Totals, ...	222.00	725.00	503.00	5.13
Averages, ...	55.50	181.25	125.75	1.28

Hominy Meal Lot.

Pigs Nos. I. and II., ...	115.50	387.25	271.75	2.77
Pig No. III., ...	57.75	196.00	138.25	1.41
Totals, ...	173.25	583.25	410.00	4.18
Averages, ...	57.75	194.42	136.66	1.39

One notes a very slight difference in favor of the hominy fed lot, this being caused perhaps by the slightly increased amount of actual dry matter found in the hominy meal.

By referring to the table, it will be noticed that each pig received 223.25 pounds of perfectly dry corn meal and 235.23 pounds of perfectly dry hominy meal.

TOTAL GAIN IN DRESSED WEIGHT.

Corn Meal Lot.

NUMBER OF FIG.	Dressed Weight at End of Experiment (Pounds).	Computed Dressed Weight at Beginning of Experiment (Pounds).	Total Gain in Dressed Weight (Pounds).	Loss in Weight in Dressing (Pounds).
Pig No. V., . . .	150.50	44.52	105.98	18.31
Pig No. VI., . . .	154.25	47.67	106.58	18.17
Pigs Nos. VII. and VIII.,	287.25	89.09	198.16	18.45
Totals, . . .	592.00	181.28	410.72	54.83
Averages, . . .	148.00	45.32	102.68	18.28

Hominy Meal Lot.

Pigs Nos. I. and II., . .	306.00	91.25	214.75	20.89
Pig No. III., . . .	152.00	44.79	107.21	22.45
Totals, . . .	458.00	136.04	321.96	43.34
Averages, . . .	152.66	45.35	107.32	21.67

DRY MATTER REQUIRED TO PRODUCE ONE POUND OF LIVE AND DRESSED WEIGHT.

Corn Meal Lot.

NUMBER OF FIG.	Live Weight (Pounds).	Dressed Weight (Pounds).
Pig No. V., ...	3.13	3.84
Pig No. VI., ...	3.12	3.81
Pigs Nos. VII. and VIII., ...	3.34	4.09
Averages, ...	3.20	3.91

Hominy Meal Lot.

Pigs Nos. I. and II., ...	3.08	3.89
Pig No. III., ...	3.03	3.90
Averages, ...	3.06	3.89

The very slight difference between the gains in the two lots is within the limit of error.

Experiment II. — Corn Meal v. Cerealine Feed.

April 12 to July 26, 1897 (106 Days). — The six pigs used in this experiment were grade Chester Whites, about five weeks old when purchased, March 2. They were brought into separate pens April 1, and the experiment began April 12. Each pig was fed 6 to 9 quarts of skim-milk daily, together with 3 ounces of grain for each quart of milk. The amount of grain was gradually increased as the animal demanded it, until some 4 pounds daily were fed. The milk never exceeded 9 quarts per day.

At the beginning of the experiment the animals were receiving 1 part protein to 3 parts carbohydrates. The ration was gradually widened, until towards the close of the experiment the nutritive ratio was as 1 to 7. The corn meal heated during the latter part of the experiment, and became somewhat musty.

TOTAL FEEDS CONSUMED.

Corn Meal Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).
Pig No. I., ...	738.00	1,608.84	152.84	243.63	204.98
Pig No. II., ...	738.00	1,608.84	152.84	243.63	204.98
Pig No. III., ...	738.00	1,608.84	152.84	243.63	204.98
Totals, ...	2,214.00	4,826.52	458.52	730.89	614.94
Averages, ...	738.00	1,608.84	152.84	243.63	204.98

Cerealine Feed Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Cerealine Feed (Pounds).	Dry Matter (Pounds).
Pig No. IV., ...	738.00	1,608.84	152.84	243.63	214.39
Pig No. V., ...	738.00	1,608.84	152.84	243.63	214.39
Pig No. VI., ...	738.00	1,608.84	152.84	243.63	214.39
Totals, ...	2,214.00	4,826.52	458.52	730.89	643.17
Averages, ...	738.00	1,608.84	152.84	243.63	214.39

Some 10 pounds more dry cerealine feed were consumed per pig than corn meal during the experiment, due to the dryer condition of the cerealine feed when fed.

TOTAL GAIN IN LIVE WEIGHT.

Corn Meal Lot.

NUMBER OF PIG.	Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).
Pig No. I., ...	51.25	188.00	136.74	1.29
Pig No. II., ...	48.50	184.00	135.50	1.28
Pig No. III., ...	43.25	184.25	141.00	1.33
Totals, ...	143.00	556.25	413.25	3.90
Averages, ...	47.67	185.42	137.75	1.30

Cerealine Feed Lot.

Pig No. IV., ...	44.00	175.50	131.50	1.24
Pig No. V., ...	41.00	170.50	129.50	1.22
Pig No. VI., ...	49.25	186.00	136.75	1.29
Totals, ...	134.25	532.00	397.75	3.75
Averages, ...	44.75	177.33	132.58	1.25

A slight gain in favor of the corn meal lot is noted.

DRY MATTER REQUIRED TO PRODUCE ONE POUND OF LIVE AND DRESSED WEIGHT.

Corn Meal Lot.

NUMBER OF PIG.	Live Weight (Pounds).	Dressed Weight (Pounds).
Pig No. I., ...	2.62	3.28
Pig No. II., ...	2.64	3.30
Pig No. III., ...	2.54	3.17
Averages, ...	2.60	3.25

Cerealine Feed Lot.

Pig No. IV., ...	2.79	3.49
Pig No. V., ...	2.84	3.54
Pig No. VI., ...	2.69	3.37
Averages, ...	2.77	3.46

The above figures show a slight difference in favor of the corn meal, rather less dry matter in corn meal being required to make a pound of growth than in cerealine feed.

Experiment III. — Corn Meal v. Cerealine Feed.

Oct. 25 to Jan. 10, 1898 (78 Days). — The six pigs employed in this experiment were a cross between the Poland-China and the Chester White. They were received early in September, when five weeks old, and allowed the run of a large pen out of doors until October 20, when they were placed in separate pens in the feeding barn, and divided as equally as possible into two lots. They were in a very vigorous condition. In this experiment the cerealine feed heated towards the close of the experiment. It was shovelled over and dried at once when this condition was observed, and the experiment continued. The pigs ate it with seeming relish at all times.

TOTAL FEEDS CONSUMED.

Corn Meal Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).
Pig No. IV., ...	468.00	1,020.24	96.92	226.50	197.06
Pig No. V., ...	468.00	1,020.24	96.92	226.50	197.06
Pig No. VI., ...	468.00	1,020.24	96.92	226.50	197.06
Totals, ...	1,404.00	3,060.72	290.76	679.50	591.18
Averages, ...	468.00	1,020.24	96.92	226.50	197.06

Cerealine Feed Lot.

NUMBER OF PIG.	SKIM-MILK CONSUMED.			GRAIN CONSUMED.	
	Quarts.	Pounds.	Dry Matter (Pounds).	Cerealine Feed (Pounds).	Dry Matter (Pounds).
Pig No. I., ...	468.00	1,020.24	96.92	226.50	201.59
Pig No. II., ...	468.00	1,020.24	96.92	222.50	198.03
Pig No. III., ...	468.00	1,020.24	96.92	226.50	201.59
Averages, ...	468.00	1,020.24	96.92	225.20	200.40

The amount of feed consumed by the two lots is practically identical.

TOTAL GAIN IN LIVE WEIGHT.

Corn Meal Lot.

NUMBER OF PIG.	Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).
Pig No. IV., ...	68.50	172.50	104.00	1.33
Pig No. V., ...	67.75	172.00	104.25	1.34
Pig No. VI., ...	66.75	173.00	106.25	1.36
Totals, ...	203.00	517.50	314.50	4.03
Averages, ...	67.67	172.50	104.83	1.34

Cerealine Feed Lot.

Pig No. I., ...	73.75	169.00	95.25	1.22
Pig No. II., ...	57.25	150.00	92.75	1.19
Pig No. III., ...	68.75	174.00	105.25	1.35
Totals, ...	199.75	593.00	293.25	3.76
Averages, ...	66.58	164.33	97.75	1.25

Each pig in the corn meal lot shows an average gain of 7 pounds over the cerealine feed pigs. This might partly be accounted for by reason of the poor condition of the cerealine feed, already mentioned.

DRY MATTER REQUIRED TO PRODUCE ONE POUND LIVE AND DRESSED WEIGHT.

Corn Meal Lot.

NUMBER OF PIG.	Live Weight (Pounds).	Dressed Weight (Pounds).
Pig No. IV., ...	2.83	3.53
Pig No. V., ...	2.82	3.52
Pig No. VI., ...	2.77	3.42
Averages, ...	2.81	3.49

Cerealine Feed Lot.

Pig No. I., ...	3.13	3.91
Pig No. II., ...	3.18	3.98
Pig No. III., ...	2.84	3.55
Averages, ...	3.05	3.81

The dry matter required to produce a pound of gain confirms the results given in the tables under gain in live weight, and shows that in this experiment a pound of live weight was produced by $\frac{1}{4}$ of a pound less of absolutely dry corn meal than of dry cerealine feed. The conclusions from these three experiments have already been given on page 28.

Composition of Feeds (used in Three Feeding Experiments).

SEPARATE INGREDIENTS OF FEEDS.	Average Skim- milk, All Experi- ments (per Cent.).	EXPERIMENT I.		EXPERIMENT II.			EXPERIMENT III.	
		Corn Meal (per Cent.).	Hominy Meal (per Cent.).	Corn Meal, I. (per Cent.).	Corn Meal, II. (per Cent.).	Cerealine Feed (per Cent.).	Corn Meal (per Cent.).	Cerealine Feed (per Cent.).
Water, . . .	90.50	12.63	7.82	20.00	14.00	12.00	13.00	11.00
Protein, . . .	-	8.78	10.59	8.86	9.03	9.55	9.64	10.96
Fat, ...	-	4.08	8.50	2.18	2.15	6.60	3.59	6.30
Extract matter, .	-	71.73	65.46	65.80	71.68	65.23	70.80	64.55
Fibre, ...	-	1.42	4.11	1.82	1.81	4.40	1.70	4.36
Ash, ...	-	1.36	3.52	1.34	1.33	2.22	1.27	2.83
Totals, . . .	-	100.00	100.00	100.00	100.00	100.00	100.00	100.00

C. THE COST OF PORK PRODUCTION.

In a section of our State the cream from the milk produced upon the farm is sold to the creamery, and the skim-milk is either fed to pigs or calves. A large number of experiments have been made at this station with growing pigs. The pigs averaged from 37 pounds in weight at the beginning of the experiments to 183 pounds when slaughtered. The daily rations have been essentially as follows:—

I. From 5 to 7 quarts of milk per day; and, beginning with 3 ounces of corn meal to each quart of milk, the grain has been gradually increased to satisfy the appetite of the animal.

II. About the same quantity of milk, and, instead of the corn meal, other carbohydrate foods, such as ground rye, wheat, hominy meal, cerealine feed and oat feed, to satisfy appetites.

III. About the same quantity of milk, together with 3 to 6 ounces of corn meal to each quart of milk, and a

mixture of one-third wheat bran, one-third gluten meal and one-third corn meal, to satisfy appetites.

More exact statements of rations will be found farther on. We rarely had more than from 5 to 7 quarts of milk daily for each pig. The animals did well with this amount of milk; if they did not secure this quantity, their growth was noticeably slower.

Explanation of Tables.

As a result of these various experiments, we have endeavored to ascertain:—

1. The price that skim-milk has returned per quart.
2. The cost of feed required to produce *a pound of live or dressed weight*, taking the various grains at a reasonable range of market prices, and allowing either $\frac{1}{4}$ or $\frac{1}{2}$ cent per quart for the milk.

In tables I., II. and III. will be found the results where milk and corn meal have been fed.

Tables IV., V. and VI. will show the results where milk and other starchy (carbohydrate) feeds have been substituted for the corn meal, such as hominy or cerealine feeds, rye and wheat meals (“grain”).

Tables VII., VIII. and IX. show the results where milk and corn meal were fed, and, in addition, wheat bran, gluten meal, etc. (“other grains”).

Tables X. and XI. show the average of all the preceding, being the results with 140 pigs, weighing 37 pounds at the beginning, and 183 pounds at the close of the experiments.

TABLE I. — *Milk and Corn Meal.*

FEEDS CONSUMED, ETC.	Quarts.	Pounds.
Total milk consumed by 21 pigs, ...	16,421	35,797.78
Total corn meal consumed by 21 pigs, ...	-	5,531.10
Live weight, actually gained, ...	-	3,012.25
Dressed weight, calculated, ...	-	2,409.80

TABLE II. — *Price obtained for Skim-milk.*

PRICE RETURNED FOR SKIM-MILK.	WITH CORN MEAL AT \$15 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AT \$17.50 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AT \$20 PER TON, AND DRESSED PORK AT —		
	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).
Per quart (cents), .	.48	.63	.77	.44	.58	.73	.39	.54	.69
Per 100 pounds (cents),	22.02	28.90	35.37	20.19	26.61	33.48	17.89	24.77	31.19

TABLE III. — *Cost of Feed per Pound of Growth produced.*

	Live Weight (Cents).	Dressed Weight (Cents).
With corn meal at \$15 per ton, and milk at $\frac{1}{4}$ cent per quart,	2.74	3.44
With corn meal at \$15 per ton, and milk at $\frac{1}{2}$ cent per quart,	4.11	5.13
With corn meal at \$17.50 per ton, and milk at $\frac{1}{4}$ cent per quart,	2.98	3.72
With corn meal at \$17.50 per ton, and milk at $\frac{1}{2}$ cent per quart,	4.33	5.41
With corn meal at \$20 per ton, and milk at $\frac{1}{4}$ cent per quart,	3.21	4.02
With corn meal at \$20 per ton, and milk at $\frac{1}{2}$ cent per quart,	4.59	5.71

TABLE IV. — *Milk and Different Starchy Feeds.*

FEEDS CONSUMED, ETC.	Quarts.	Pounds.
Total milk consumed by 22 pigs, ...	13,153	28,630
Total "grain" consumed by 22 pigs, ...	-	5,135
Live weight, actually gained, ...	-	2,597
Dressed weight, calculated, ...	-	2,078

TABLE V. — *Price obtained for Skim-milk.*

PRICE RETURNED FOR SKIM-MILK.	WITH "GRAIN" AT \$15 PER TON, AND DRESSED PORK AT —			WITH "GRAIN" AT \$17.50 PER TON, AND DRESSED PORK AT —			WITH "GRAIN" AT \$20 PER TON, AND DRESSED PORK AT —		
	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).
Per quart (cents), .	.50	.65	.81	.45	.60	.76	.40	.56	.87
Per 100 pounds (cents),	22.90	30.10	37.10	20.60	27.80	35.10	18.35	25.69	39.91

TABLE VI. — *Cost of Feed per Pound of Growth produced.*

	Live Weight (Cents).	Dressed Weight (Cents).
With "grain" at \$15 per ton, and skim-milk at $\frac{1}{4}$ cent per quart,	2.75	3.43
With "grain" at \$15 per ton, and skim-milk at $\frac{1}{2}$ cent per quart,	4.01	5.01
With "grain" at \$17.50 per ton, and skim-milk at $\frac{1}{4}$ cent per quart,	3.00	3.75
With "grain" at \$17.50 per ton, and skim-milk at $\frac{1}{2}$ cent per quart,	4.26	5.32
With "grain" at \$20 per ton, and skim-milk at $\frac{1}{4}$ cent per quart,	3.24	4.05
With "grain" at \$20 per ton, and skim-milk at $\frac{1}{2}$ cent per quart,	4.51	5.63

TABLE VII. — *Milk, Corn Meal, Bran, Gluten Meal, etc.*

FEEDS CONSUMED, ETC.	Quarts.	Pounds.
Total milk consumed by 97 pigs, ...	62,319	135,855
Total corn meal consumed by 97 pigs, ...	-	21,602
Total "other grains" consumed by 97 pigs, ...	-	12,663
Live weight actually gained, ...	-	15,080
Dressed weight calculated, ...	-	12,064

TABLE VIII. — *Price obtained for Skim-milk.*

PRICE OBTAINED FOR SKIM-MILK.	WITH CORN MEAL AT \$15 PER TON, "OTHER GRAINS" AT \$17.50 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AT \$17.50 PER TON, "OTHER GRAINS" AT \$20 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AT \$20 PER TON, "OTHER GRAINS" AT \$22.50 PER TON, AND DRESSED PORK AT —		
	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).
Per quart (cents), .	.53	.72	.92	.45	.65	.85	.39	.59	.78
Per 100 pounds (cents),	24.30	33.20	42.10	21.20	30.00	39.00	18.00	27.00	36.00

TABLE IX. — *Cost of Feed per Pound of Growth produced.*

	Live Weight (Cents).	Dressed Weight (Cents).
With corn meal at \$15 "other grains" at \$17.50 and milk at $\frac{1}{2}$ cent per quart,	2.84	3.55
With corn meal at \$15 "other grains" at \$17.50 and milk at $\frac{3}{4}$ cent per quart,	3.87	4.84
With corn meal at \$17.50 "other grains" at \$20 and milk at $\frac{1}{2}$ cent per quart,	3.13	3.90
With corn meal at \$17.50 "other grains" at \$20 and milk at $\frac{3}{4}$ cent per quart,	4.16	5.20
With corn meal at \$20 "other grains" at \$22.50 and milk at $\frac{1}{2}$ cent per quart,	3.41	4.26
With corn meal at \$20 "other grains" at \$22.50 and milk at $\frac{3}{4}$ cent per quart,	4.44	5.55

TABLE X. — *Price obtained for Skim-milk (All Experiments).*

AVERAGE PRICE OBTAINED FOR SKIM-MILK.	WITH CORN MEAL AND OTHER STARCHY FOODS AT \$15 PER TON, "OTHER GRAINS" AT \$17.50 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AND OTHER STARCHY FOODS AT \$17.50 PER TON, "OTHER GRAINS" AT \$20 PER TON, AND DRESSED PORK AT —			WITH CORN MEAL AND OTHER STARCHY FOODS AT \$20 PER TON, "OTHER GRAINS" AT \$22.50 PER TON, AND DRESSED PORK AT —		
	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).	Five Cents (per Pound).	Six Cents (per Pound).	Seven Cents (per Pound).
Per quart (cents), .	.50	.67	.83	.45	.61	.78	.39	.56	.78
Per 100 pounds (cents),	23.07	30.73	38.19	20.66	28.14	35.86	18.08	25.82	35.70

TABLE XI. — *Average Cost of Feed per Pound of Growth produced.*

	Live Weight (Cents).	Dressed Weight (Cents).
With corn meal at \$15 "other grains" at \$17.50, milk at $\frac{1}{4}$ cent per quart, .	2.78	3.47
With corn meal at \$15 "other grains" at \$17.50, milk at $\frac{1}{2}$ cent per quart, .	4.00	4.99
With corn meal at \$17.50 "other grains" at \$20, milk at $\frac{1}{4}$ cent per quart, .	3.04	3.79
With corn meal at \$17.50 "other grains" at \$20, milk at $\frac{1}{2}$ cent per quart, .	4.25	5.31
With corn meal at \$20 "other grains" at \$22.50, milk at $\frac{1}{4}$ cent per quart, .	3.63	4.53
With corn meal at \$20 "other grains" at \$22.50, milk at $\frac{1}{2}$ cent per quart, .	4.51	5.63

D. RATIONS FOR GROWING PIGS.

RATION No. I. — *With Unlimited Supply of Milk.*

WEIGHT OF PIGS.	RATIONS.
20 to 60 pounds, .	3 ounces of corn meal * to each quart of milk.
60 to 100 pounds, .	6 ounces of corn meal to each quart of milk.
100 to 180 pounds, .	8 ounces of corn meal to each quart of milk.

RATION No. II. — *With Limited Supply of Milk (5 to 6 quarts per Pig daily).*

WEIGHT OF PIGS.	RATIONS.
20 to 60 pounds, .	} 3 ounces of corn meal * to each quart of milk, and then gradually increase corn meal to satisfy appetites.
60 to 100 pounds, .	
100 to 180 pounds, .	

* Wheat, rye or hominy meals can be substituted for corn meal.

RATION No. III.

WEIGHT OF PIGS.	RATIONS.
20 to 60 pounds, .	Milk at disposal, plus mixture of one-third corn meal, one-third wheat bran and one-third gluten meal, to satisfy appetites.
60 to 100 pounds, .	Milk at disposal, plus mixture of one-half corn meal, one-quarter wheat bran and one-quarter gluten meal, to satisfy appetites.
100 to 180 pounds, .	Milk at disposal, plus mixture of two-thirds corn meal, one-sixth wheat bran and one-sixth gluten meal, to satisfy appetites.

RATION No. IV.*

WEIGHT OF PIGS.	RATIONS.
20 to 60 pounds, .	3 ounces of corn meal to each quart of milk, and 4 ounces of gluten feed as a substitute for quart of milk.
60 to 100 pounds, .	Milk at disposal, and mixture of one-half corn meal and one-half gluten feed, to satisfy appetites.
100 to 180 pounds, .	Milk at disposal, and mixture of two-thirds corn meal and one-third gluten feed, to satisfy appetites.

* This ration is preferable to Ration No. II.

E. EXPERIMENTS WITH SALT HAY.

The extensive series of experiments carried on to ascertain the nutritive value of different kinds of salt hay were completed and the experiments and results published in Bulletin No. 50, in January, 1898, to which the reader is referred for all details.

F. EXPERIMENTS TO ASCERTAIN THE EFFECT OF DIFFERENT AMOUNTS OF PROTEIN UPON THE COST AND QUALITY OF MILK.

During the winter of 1897-98 two experiments, with twelve cows, were carried out, to investigate the effect of 1.50, 2 and 2.50 pounds of protein upon the cost and quality of milk. The total amount of digestible nutrients fed daily was the same in each case. Experiment I. extended over nine weeks and Experiment II. over four weeks. This work has not been published. About 5 per cent. more milk was produced on 2 pounds, and 10 per cent. more on $2\frac{1}{2}$ pounds, of protein daily, than when the animals received $1\frac{1}{2}$ pounds each. The quality of the milk was scarcely changed. The cost of the different rations will depend upon the cost of the several concentrated feeds. As the market has been for the past two years, milk produced by aid of the rations containing $2\frac{1}{2}$ pounds of protein daily would cost rather less than that produced by $1\frac{1}{2}$ or 2 pounds. The manure derived from the highest protein ration would be 10 per cent. more valuable, and the animals generally have a better appearance than when receiving but $1\frac{1}{2}$ pounds per day. It is believed that a continuous feeding of 2 or $2\frac{1}{2}$ pounds of protein daily tends, to some extent, to develop the milk-producing capacity of the cow. Animals that will

not stand a reasonably generous feeding had better be consigned to the butcher. The writer is of the opinion that animals weighing from 800 to 1,000 pounds, producing from 10 to 15 quarts of milk per day, should receive about 2.5 pounds of digestible protein and 15 to 16 pounds of total nutrients daily. This is in accordance with Wolff's rations. When protein is costly, it might be advisable to reduce the amount to 2 pounds daily. The detailed records of these and other experiments along this line will be published later.

G. DIGESTION EXPERIMENTS.

During the past three years there have been made about forty successful digestion experiments, mostly with the various concentrated feeds, to ascertain their value for feeding purposes. The details of the experiments have not been published. Some of the results (digestion coefficients) have been published in Bulletin No. 50, and in the annual reports for 1896 (page 135) and 1897 (page 84); others follow below. The results have been utilized in showing the nutritive value of a number of coarse fodders, and in preparing a key to the comparative values of concentrated feeds, as given in Bulletin No. 56 (page 23). It is hoped to publish the details of the experiments before long.

Digestion Coefficients resulting from Digestion Experiments.

KIND OF FEED STUFF.	Number of Dif-ferent Sam-ples.	Number of Single Trials.	Dry Matter (per Cent.).	Protein (per Cent.).	Fat (per Cent.).	Extract (per Cent.).	Fibre (per Cent.).	Ash (per Cent.).
Hay (largely <i>Poa pratensis</i>), . . .	1	6	62	61	50	63	65	46
Hay (largely <i>Poa pratensis</i>), . . .	1	4	60	58	53	61	60	50
Average, both samples, . . .	2	10	61	60	51	62	63	48
Hay of mixed grasses (late cut), . . .	1	2	53	54	39	54	56	26
Hay of mixed grasses (late cut), . . .	1	2	57	55	44	57	59	42
Barn-yard millet hay (late blossom), . . .	1	3	57	64	46	52	62	63
Barn-yard millet (green, blossom), . . .	1	2	74	68	64	76	74	66
Barn-yard millet (green, week later than above), . . .	1	1	67	72	61	65	71	61
Peas and oats (green, in blossom), . . .	1	3	70	70	57	76	68	49
Vetch and oats (green, in blossom), . . .	1	3	67	75	47	68	68	53
Corn ensilage (Pride of the North), . . .	1	2	74	45	77	82	80	26
Hominy meal, ...	1	1	89	53	94	94	-	-
Cerealine feed, ...	1	3	90	80	81	95	82	-
Peoria gluten feed, ...	1	3	91	85	88	95	-	-
Quaker oat feed, ...	1	3	62	81	89	67	43	-
Victor corn and oat feed, ...	1	3	75	71	87	83	48	-
H. O. dairy feed, ...	1	2	65	78	85	70	41	-
H. O. horse feed, ...	1	1	70	74	84	79	35	-

REPORT OF THE AGRICULTURIST.

WM. P. BROOKS; ASSISTANT, H. M. THOMSON.

SOIL TESTS.

During the past season four soil tests upon the co-operative plan agreed upon in Washington in 1889 have been carried out. Two of these were upon our own grounds, — one with corn and the other with onions as the crop; one in Norwell, Plymouth County, with oats; and one in Montague, Franklin County, also with oats.

1. Soil Test with Corn. Amherst.

The past is the tenth season that the experiment on this field has been in progress. The crops in order of rotation have been corn, corn, oats, grass and clover, grass and clover, corn followed by mustard as a catch crop, rye, soy beans, white mustard, and this year corn once more. During all this time four of the fourteen plots into which the field is divided have received neither manure nor fertilizer; three have received but a single important manurial element, — every year the same; three have received each year two important elements; one has received all three yearly; and one each has received yearly lime, plaster and farm-yard manure. It will be seen that the greater part of the field has remained either entirely unmanured or has had but a partial manuring, and it will be readily understood that the degree of exhaustion of most of the plots is considerable. The nothing plots produce this year an average of about twelve bushels of shelled corn per acre; and even this figure is somewhat too high, owing to the fact that after this long period one of the nothing plots which adjoins the plot which has been yearly manured at the rate of five cords per acre

begins to feel the effect of the high fertility of its neighbor, although separated from it by a strip three and one-half feet wide.

The single-element plots, one receiving nitrate of soda only yearly, another phosphoric acid and the third potash, give this year practically equal crops of grain, respectively at the rate of 20.6, 18.5 and 19.8 bushels per acre. The nitrate of soda and dissolved bone-black give a crop at the rate of 32 bushels per acre, while nitrate of soda and potash give at the rate of but 10.9 bushels. The dissolved bone-black and muriate of potash do much better, yielding at the rate of 41.2 bushels. The fertilizer supplying nitrogen, phosphoric acid and potash gives a crop of 55.9 bushels, while manure gives 67.7 bushels.

It may be remembered that in each of the three previous years in which this field has produced corn the muriate of potash has, whether singly or in any combination, proved much more useful than either of the other fertilizers used. There is much evidence in the behavior of the crops this year, during the growing season and in the results, that this salt is proving injurious in its chemical effect upon the soil. I believe this effect to be a loss of lime in the form of chloride by leaching, but cannot regard this as yet proven. I will present the facts apparently bearing upon the case, and leave full discussion to a later report.

1. During the early part of the growing season the corn upon all the plots which had received muriate of potash was distinctly behind that upon other plots.

2. As the season advanced, the corn upon these plots gradually lost its sickly appearance, gained upon that in the other plots, eventually excelling, in the case of the plot receiving nitrogen, phosphoric acid and potash, that in all other plots except the manure plot.

3. This unhealthy appearance of the corn early in the season, followed by great improvement later, is analogous to effects noticed in other experiments,* where chlorides have been used, and where liming the land has remedied the faulty condition.

* For example, Plot 6, Field A. See report State Experiment Station for 1896.

4. On that plot receiving dissolved bone-black as well as muriate of potash, the crop was in the end a good one. As is well known, the dissolved bone-black contains a large amount of sulphate of lime. It is believed that this may take the place of the lime leached from the soil as a consequence of the use of the muriate of potash, or at least that it corrects in some way the faulty condition consequent upon the use of this salt. It may here be pointed out that a similar corrective influence is evident in the results obtained both in 1897 and 1898 upon our other home-test acre, which will immediately be discussed.

It is of interest, further, to point out that the crop this year upon the lime plot was not quite equal to the average of the nothing plots, while that of the plaster plot (sulphate of lime) was about double that of the lime plot. In the earlier years of this soil test the yield of neither the lime nor the plaster plot ever exceeded that of the nothings, but for the past three years the plaster plot has been relatively gaining. The explanation of this difference between the effect of plaster and lime is not apparent. It will be made the subject of future study.

Conclusions.

1. The yield of the plot which for ten years has received only phosphoric acid and potash (41.2 bushels per acre) illustrates in a striking way the comparative independence of the corn crop of supplied nitrogen upon this soil.

2. The crop raised where nitrogen, phosphoric acid and potash have been yearly applied (nitrate of soda, dissolved bone-black and muriate of potash) for ten years shows that profitable results may be obtained by the use of fertilizers alone. The yearly cost of the application to this plot has been from \$10 to \$12. The crops have not been much inferior to those on the plot to which manure at the rate of 5 cords per acre has been yearly applied. The two crops this year are, respectively: for the fertilizer, 55.9 bushels; for the manure, 67.7 bushels. The extra 11 bushels of corn will not cover the added cost of the manure, as compared with the fertilizer; and in earlier years the differences in yield have been relatively much smaller than this year.

3. The problems suggested by the results of the year must be regarded as the most valuable product of this experiment. These problems are not solved. Their solution will throw important light upon methods to be employed in compounding and selecting fertilizers.

2. *Soil Test with Onions. Amherst.*

This experiment occupied a field which has been employed in work of this kind for nine years, the several plots having been every year manured alike, as described under the "Soil test with corn." The crops in the order of rotation have been: potatoes, corn, soy beans, oats, grass and clover, grass and clover, cabbages and rutabaga turnips, and potatoes. The land was ploughed in the fall of 1897, and sown with winter rye as a cover crop. The rye was turned in before it had made much of a spring growth, April 21. Fertilizers were employed this year in double the usual quantities; viz., nitrate of soda at the rate of 320 pounds; dissolved bone-black, 640 pounds; and muriate of potash, 320 pounds, per acre. These fertilizers are each used upon one plot singly, in pairs, and upon one plot all three together.

The seed was sown in the customary manner, but more thickly, on May 9. Germination was prompt and perfect. The development of the crop throughout the season was most suggestive in problems for future solution. At the start plants upon the four plots, potash alone, potash and bone-black, potash and nitrate, and potash with both bone-black and nitrate, were much ahead of those on the plots not manured with potash. There was every indication that this element would almost entirely control the crop, for there was good growth wherever potash was applied, and but feeble growth elsewhere. The potash plots, however, after about four weeks, began to lose their superiority; and it was not long ere many of the plants upon these plots became manifestly very unthrifty, and before the end of the season many of them had died. Meanwhile, the phosphoric acid plots began to gain; and the results show that this, more than either the nitrogen or the potash supply, con-

trolled the product. The crop was very light, however, even upon the best plot, which was at the rate of 116.9 bushels per acre, upon the plot receiving nitrate of soda and dissolved bone-black. Upon the plots receiving these two fertilizers and muriate of potash the crop amounted to only 16.3 bushels per acre. Here is strong evidence that the muriate of potash has produced in the soil of this field conditions absolutely prejudicial to the growth of the onion.

Last year this field was in potatoes under the same system of manuring, but with half the quantities employed this year. The crop of potatoes on the nitrate and bone-black was much heavier than on these two and potash, and in commenting upon this fact in my annual report I wrote: "The apparent superiority of the phosphoric acid and nitrogen is chiefly due to the fact that the plot to which these two elements alone were applied was for some reason (not believed to be the effect of the fertilizer alone) nearly twice as great as that upon any other plot. Had the crop where the potash was added to the nitrogen and phosphoric acid been better or even as good as that where the phosphoric acid and nitrogen alone were used, we should be justified in the conclusion that nitrogen and phosphoric acid are the elements chiefly required. The crop where all three elements were combined was, however, much inferior to that where the nitrogen and phosphoric acid were used without potash. We must, therefore, conclude that some disturbing factor, at present unknown, influenced the results."

In view of the similar relative results upon the two plots under discussion this year, I am now forced to conclude that I was mistaken last year in supposing that the superiority of the plot receiving nitrogen and phosphoric acid only was not "the effect of the fertilizer alone."

I now believe that the muriate of potash has proved actually injurious to the last two crops, and that the explanation (the loss of lime which it causes) already suggested accounts for this effect.

The Proper Course as regards Potash Supply.

What, then, in view of such results, are we to recommend? Clearly not to cease using potash, — we have been unable to raise good crops without it. It is believed the remedy will be found in one of three directions; viz., (1) the occasional liberal use of lime where muriate of potash is employed; (2) the use of other potash salts, such as carbonate or sulphate; or (3) the employment of wood ashes as a source of potash. Should potash be supplied in the form of either carbonate or sulphate, lime leaches from the soil much less rapidly; the same is true of ashes, and these, moreover, supply much lime. This entire question, however, demands further experimental study, and I am not at present prepared to give definite advice upon this point.

Again, in conclusion it may be said the most profitable results of the year's work are the suggestions for future lines of work, which, being completed, must throw much needed light upon the problems connected with the use of fertilizers.

3. Soil Test with Oats. Norwell.

The past was the third season of soil test work upon this acre, the two preceding crops having both been corn. The results with both of the tests with corn have indicated a strong demand for potash by corn on this soil. These results were thus in entire agreement with those obtained in almost all of the large number of soil tests with this crop that during the past ten years have been carried out under my direction in all the counties of the State.

The results the past season with oats seem also to be in general accord with results previously obtained in other sections with this crop. This is not shown clearly by the figures giving the yields, for the reason that excessive rains flooded parts of the field which is nearly flat soon after the seed was sown, rendering germination poor and uneven.

From examination during the growing season I feel certain that in this experiment it was the nitrate of soda which most largely benefited the crop. The crop on dissolved bone-black was at the rate of 9.7 bushels per acre; on dissolved

bone-black and nitrate of soda it was 13 bushels. On muriate of potash the crop was 10 bushels; on the muriate and nitrate of soda it was 13.6 bushels. On the bone-black and muriate of potash the crop was at the rate of 9.8 bushels per acre; on these two fertilizers and nitrate of soda it was 17.8 bushels. The soil is clearly in need also of both phosphoric acid and potash for good crops, although the figures of this year afford no certain index to its condition, owing to the damage by water above mentioned.

4. *Soil Test with Oats. Montague.*

The present is also the third season of soil test work upon this soil, the preceding crops having been corn, which, owing to accidental conditions, did not give decisive results. The experiment of the past season is eminently satisfactory. The five nothing plots have given fairly even crops, varying from 18.8 to 24.4 bushels per acre of grain, averaging 21.5 bushels; while the straw yield has varied on these plots from 1,470 to 1,830 pounds, averaging 1,554 pounds, per acre. The crop on nitrate of soda alone was 30.3 bushels of grain and 2,210 pounds of straw; on dissolved bone-black, 24.4 bushels and 1,550 pounds; on muriate of potash, 21.3 bushels and 1,470 pounds. This marked increase on the nitrate of soda, as compared with the almost complete absence of effect of the other fertilizers used alone, is striking.

The dissolved bone-black and muriate of potash together gave 23.8 bushels of grain and 1,810 pounds of straw. Again we see practically no effect; but when we use nitrate of soda with these two fertilizers, we have a crop of 31.3 bushels of grain and 2,710 pounds of straw. Nitrate of soda with muriate of potash gives 30.3 bushels and 2,350 pounds, and with dissolved bone-black it gives 31.3 bushels and 2,330 pounds.

It will be seen, then, that in this experiment it was the nitrate of soda alone which proved effective. Alone and in all its combinations it gave a large increase in crop, and in all cases practically the same. The average increase apparently due to the use of this fertilizer amounted to 8 bushels of grain and 804 pounds of straw. The average increases ap-

parently due to the use of dissolved bone-black were 2.1 bushels of grain and 193.4 pounds of straw; those apparently due to the muriate of potash were 1 bushel of grain and 175 pounds of straw.

Manure at the rate of 5 cords per acre gave about 806 pounds more straw, but only .7 bushels more grain than the complete fertilizer, costing some \$13 per acre less; and the manure crop did not indeed surpass the crop on nitrate of soda alone in much greater degree. The latter application cost \$3.20 per acre, while the manure can scarcely be estimated at less than \$25.

This Montague experiment is one of the most perfectly satisfactory in a long series of such experiments; and it is a pleasure to see that its teaching as to the value of nitrate of soda for the oat crop is so entirely in agreement with that of other experiments with this crop.

For convenience is appended a statement giving the arrangement of plots and the system of manuring in nearly all our soil test work, which now extends over ten seasons:—

- Plot 1, nothing.
- Plot 2, nitrate of soda, 160 pounds per acre.
- Plot 3, dissolved bone-black, 320 pounds per acre.
- Plot 4, nothing.
- Plot 5, muriate of potash, 160 pounds per acre.
- Plot 6, { nitrate of soda, 160 pounds per acre.
 { dissolved bone-black, 320 pounds per acre.
- Plot 7, { nitrate of soda, 160 pounds per acre.
 { muriate of potash, 160 pounds per acre.
- Plot 8, nothing.
- Plot 9, { dissolved bone-black, 320 pounds per acre.
 { muriate of potash, 160 pounds per acre.
- Plot 10, { nitrate of soda, 160 pounds per acre.
 { dissolved bone-black, 320 pounds per acre.
 { muriate of potash, 160 pounds per acre.
- Plot 11, plaster, 160 pounds per acre.
- Plot 12, nothing.
- Plot 13, manure, 5 cords per acre.
- Plot 14, lime, 160 pounds per acre.
- Plot 15, nothing.

MANURE ALONE *v.* MANURE AND POTASH.

An experiment in continued corn culture for the comparison of an average application of manure with a smaller application of manure used in connection with muriate of potash was begun in 1890. A full account will be found in the annual reports of 1890-95, and in the latter year a general summary of the results is given.

The land used in this experiment was seeded with a mixture of timothy, red-top and clover in the standing corn of 1896. A good stand of grass and clover was secured, although the latter was rather unevenly developed in different parts of the field, suggesting a possible lack of thoroughness in mixing the seeds.

No manure or potash was used in 1897. The field includes four plots, of one-fourth an acre each. The average results for 1897 are shown below : —

Plots 1 and 3 (manure alone, 6 cords per acre, 1890-96) : hay, 1,403½ pounds; rowen, 784 pounds.

Plots 2 and 4 (manure, 3 cords per acre, 1890-92; 4 cords, 1893-96; and potash, 160 pounds per acre) : hay, 961¼ pounds; rowen, 536½ pounds.

This field was continued in grass and clover during the present season, but manure and potash were applied as shown below : —

Plot 1, manure, 1 cord; weight, 5,087.5 pounds.

Plot 2, { manure, .5 cord; weight, 2,712.5 pounds.
 { muriate of potash; weight, 40 pounds.

Plot 3, manure, 1 cord; weight, 5,372.5 pounds.

Plot 4, { manure, .5 cord; weight, 2,855 pounds.
 { muriate of potash; weight, 40 pounds.

The manure applied to each plot was sampled and analyzed, and from the analyses the amounts of the three most essential elements of plant food applied per acre were calculated, with results shown below : —

Manurial Ingredients per Plot.

PLOTS.	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).
Plot 1, in manure, ...	20.9	14.2	25.9
Plot 2, { in manure, ...	11.4	6.2	15.2
{ in muriate of potash, ...	—	—	19.9
			35.1
Plot 3, in manure, ...	22.0	15.0	26.9
Plot 4, { in manure, ...	15.1	9.7	18.0
{ in muriate of potash, ...	—	—	19.9
			37.9

The manure was applied on April 1, the muriate of potash to plots 2 and 4 on April 9.

During the later growth of the mixed grasses and clovers upon these plots it was plainly evident that the clover was relatively more prominent upon plots 2 and 4. The first crop was cut on June 20; the second, on August 26, and both were secured in excellent condition.

Yield per Plot.

PLOTS.	Hay (Pounds).	Rowen (Pounds).
Plot 1, ...	1,395	840
Plot 2, ...	1,120	730
Plot 3, ...	1,460	810
Plot 4, ...	1,497	830

Average Yield per Acre.

Plots 1 and 3 (manure alone), ...	5,710	3,300
Plots 2 and 4 (manure and potash), ...	5,235	3,120

Combining the figures showing the yields in hay and rowen, we find that the average of plots 1 and 3 is at the rate of 9,010 pounds per acre; and of plots 2 and 4, 8,355 pounds. There is, then, a difference of 655 pounds only in total yields per acre, in favor of the large application of manure alone. This amount is quite insufficient to cover the larger cost of the acre application (\$6.80 in the case of

the manure alone). This field has now been broken up, and will next year be put once more into corn, when it is believed the beneficial effect of the large growth of clover upon plots 2 and 4 will become apparent.

“SPECIAL” CORN FERTILIZER *v.* FERTILIZER RICHER IN POTASH.

This experiment was begun with a view to comparing the results obtained with a fertilizer proportioned like the average “*special*” corn fertilizers found upon the markets in 1891 with those obtained with a fertilizer richer in potash, but furnishing less nitrogen and phosphoric acid.

Corn was grown during each of the years from 1891 to 1896 inclusive. From 1891 to 1895 it was found that the fertilizer richer in potash gave the more profitable results. In 1896 there was no practical difference. It was decided during the season of 1896 that it might be possible to derive a greater benefit from the larger quantity of potash applied to two of the four plots if grass and clover should be grown in rotation with the corn. Accordingly the land was seeded with a mixture of timothy, red-top and clover in the standing corn in July, 1896. The field is divided into four plots of one-fourth of an acre each. The materials supplied to the several plots are shown in the following table: —

FERTILIZERS.	Plots 1 and 3 (Pounds Each).	Plots 2 and 4 (Pounds Each).
Nitrate of soda, ...	20.0	18.0
Dried blood, ...	30.0	30.0
Dry ground fish, ...	30.0	20.0
Plain superphosphate, ...	226.0	120.0
Muriate of potash, ...	22.5	60.0
Cost of materials per plot, ...	\$3 23	\$3 10

In 1897 the average (both hay and rowen) produced by plots 1 and 3 was 873.5 pounds, or 3,494 pounds per acre; on plots 2 and 4, 860.5 pounds, or 3,442 pounds per acre. This difference is too small to be of practical significance. The rowen crop was heavier on plots 2 and 4 than on plots

1 and 3, showing an apparent influence of the greater amount of potash used on these plots in a larger proportion of clover.

For the present season the fertilizers were applied as last year, being evenly broadcasted on April 11. The first crop was cut June 21. It consisted largely of red-top, which was then not fully in bloom. The second crop was cut August 26. Both crops were well secured, and the yields are shown below:—

Yield of Hay and Rowen, 1898.

PLOTS.	Hay (Pounds).	Rowen (Pounds).
Plot 1 (lesser potash), ...	670	530
Plot 2 (richer in potash), ...	585	440
Plot 3 (lesser potash), ...	540	365
Plot 4 (richer in potash), ...	550	415

Average Rates per Acre.

Plots 1 and 3, ...	2,420	1,790
Plots 2 and 4, ...	2,270	1,710

We have then, as will be seen, an average product, from the application richer in nitrogen and phosphoric acid, at the rate of 150 pounds of hay and 80 pounds of rowen per acre more than from the application poorer in these elements and richer in potash. It is believed that the failure of plots 2 and 4 to show greatly superior development of clover is in part due to variations in physical characteristics of the soil of the different plots, leading to unfavorable moisture conditions, which prevented an even catch of clover on plots 2, 3 and 4, but did not injuriously affect Plot 1. Further, it should be pointed out that results which will be published later in this report in the case of clover experiments on a series of plots manured alternately with muriate of potash and with sulphate of potash indicate that the long-continued use of muriate of potash in liberal amounts without liming is unfavorable to the healthy development of clover. This field has now been broken up, and will be again put into corn next season.

LEGUMINOUS CROPS (CLOVER, PEA AND BEAN OR "POD"
FAMILY) AS NITROGEN GATHERERS. (FIELD A.)

This experiment is a continuation of a series begun in 1889. The objects in view have been : —

1. To determine the extent to which plants of the clover family are capable of enriching the soil in nitrogen taken by them from the air through the agency of the nodular bacteria found upon their roots.

2. To compare nitrate of soda, sulphate of ammonia, dried blood and farm-yard manure as sources of nitrogen.*

The plots, eleven in number, are one-tenth acre each, and are numbered 0 to 10. Three plots (4, 7 and 9) have received no nitrogen-containing manure or fertilizers since 1884; one (0) has received farm-yard manure; two (1 and 2), nitrate of soda; three (5, 6, and 8), sulphate of ammonia; and two (3 and 10), dried blood every year since 1889. These materials have been used in amounts to furnish nitrogen at the rate of 45 pounds per acre each year.

All the plots have received yearly equal quantities of phosphoric acid and potash; viz., 80 pounds per acre of the former and 125 pounds of the latter from 1889 to 1894 and the past two seasons; but in 1894 and 1895, double these quantities. To some of the plots the potash is applied in the form of potash-magnesia sulphate; to others, in the form of muriate. The results with the former salt have been superior to those with the latter, as a rule, particularly when used in connection with sulphate of ammonia.

Up to this year we may briefly characterize the results, in so far as these have a bearing upon the two main questions proposed, as follows : —

1. The leguminous crops grown (soy beans in 1892, 1894 and 1896) have not appeared to enrich the soil in nitrogen, if we accept the results with the next following crop as affording a basis of judgment.

2. The different sources of nitrogen have ranked on the

* Only such details are given here as are necessary to an understanding of the nature of the experiment. Full particulars will be found in our ninth and tenth annual reports.

average in the following order: nitrate of soda, farm-yard manure, dried blood and sulphate of ammonia.

After the oat crop of 1897 was harvested the land was ploughed, and late in July sown to Mammoth red clover. Germination was quick and good; but the young plants on all plots failed to flourish, and soon took on a most unhealthy appearance on all except the manure plot, and even on this their development was not what could be desired. In April of this year the plots were most carefully examined, and the clover ranked as follows: plot 0, good; 1, fair; 2, poorer than 1; 3, like 2; 4, mostly dead; 5, all dead; 6, all dead; 7, like 2; 8, best in field (limed in 1896); 9, like 2; 10, somewhat better than 2.*

The general average of condition was so poor that it was decided to plough the field, which was done on April 18. From previous observations upon this series of plots it was decided that liming was called for, and accordingly 200 pounds per plot of partially air-slaked lime was spread on and harrowed in on April 20. Eight hundred pounds of manure was applied to plot 0 on April 23, and on April 26 the fertilizers were applied.

The plots were all sown to Clydesdale oats on April 27, $8\frac{1}{2}$ pounds per plot. The analysis of the manure and a table showing fertilizer treatment and yields follow:—

Analysis of Manure Used.

	Per Cent.
Moisture, ...	72.53
Nitrogen, ...	.43
Phosphoric acid, ...	.16
Potash, ...	.26

* For manuring of these plots, see page 58.

*Nitrogen Experiment. — Fertilizer Treatment and Yields of Oats,
1898.*

PLOTS	FERTILIZERS.	Pounds.	Weight of Oats (Pounds).	Weight of Straw (Pounds).	Bushels Oats per Acre.	Weight of Straw per Acre (Pounds).
Plot 0,	{ Barn-yarn manure, . . . Potash-magnesia sulphate, . Dissolved bone-black, . .	{ 800.0 32.0 18.0 }	83.0	125	25.90	1,250.0
Plot 1,	{ Nitrate of soda, . . . Potash-magnesia sulphate, . Dissolved bone-black, . .	{ 29.0 48.5 50.0 }				
Plot 2,	{ Nitrate of soda, . . . Potash-magnesia sulphate, . Dissolved bone-black, . .	{ 29.0 48.5 50.0 }				
Plot 3,	{ Dried blood, . . . Muriate of potash, . . . Dissolved bone-black, . .	{ 43.0 25.0 50.0 }	96.0	155	30.00	1,550.0
Plot 4,	{ Muriate of potash, . . . Dissolved bone-black, . .	{ 25.0 50.0 }				
Plot 5,	{ Ammonium sulphate, . . . Potash-magnesia sulphate, . Dissolved bone-black, . .	{ 22.5 48.5 50.0 }				
Plot 6,	{ Ammonium sulphate, . . . Muriate of potash, . . . Dissolved bone-black, . .	{ 22.5 25.0 50.0 }	109.0	160	34.10	1,600.0
Plot 7,	{ Muriate of potash, . . . Dissolved bone-black, . .	{ 25.0 50.0 }				
Plot 8,	{ Ammonium sulphate, . . . Muriate of potash, . . . Dissolved bone-black, . .	{ 22.5 25.0 50.0 }				
Plot 9,	{ Muriate of potash, . . . Dissolved bone-black, . .	{ 25.0 50.0 }	76.5	95	23.90	950.0
Plot 10,	{ Dried blood, . . . Potash-magnesia sulphate, . Dissolved bone-black, . .	{ 43.0 48.5 40.0 }				
Average of no-nitrogen plots, ...						
Average of muriate of potash plot (as far as comparable), ...					32.05	1,595.0
Average of sulphate plots (as far as comparable), ...					35.20	1,416.7

It is important to point out that the oats on the several plots ripened at different times. An effort was made to harvest the crop upon all at the same stage of maturity. With this end in view, plots 1, 2 and 5 were cut on July 29; plots 6, 8, 9 and 10, on July 30; and the balance on August 2. Meanwhile, there had occurred the phenomenally heavy rain and wind of July 30, p.m., and numerous other heavy showers; moreover, the weather continued per-

sistently had much of the time until the middle of August, and there was much loss through shelling of the grain. The straw, therefore, perhaps better than the grain, affords an index to the relative value of the several manurings. The rank of the different sources of nitrogen, taking straw production as the basis of estimation, is nitrate of soda, sulphate of ammonia, dried blood and farm-yard manure.

After the oats were harvested the land was ploughed, and without further manuring sown to Mammoth red clover, which at the time winter set in was in excellent condition.

The reader will naturally, perhaps, conclude that the better condition of the clover this year as compared with last is a consequence of the liming, and I am of opinion that this may be the case; but nevertheless I cannot regard this as certain, for the reason that upon Field B (reported upon below), where clover sown in the summer of 1897 failed, we have now an excellent stand of this crop obtained by sowing seed where it had failed this spring, without liming or reploughing.

MURIATE v. SULPHATE OF POTASH FOR CLOVER. (FIELD B.)

Field B is laid off in eleven equal plots, of two-fifteenths of an acre each. The manuring has been uniform since 1884. These plots are numbered from 11 to 21. *Every year each plot has received an application of ground bone at the rate of 600 pounds per acre. The odd-number plots have yearly received muriate of potash and the even-number plots the high-grade sulphate, in each case at the uniform rate of 400 pounds per acre.* This series of plots has produced a great variety of crops, including potatoes, corn, grasses, oats and barley each, with vetches, rye and clovers. The crops have been generally excellent. Full details will be found in the tenth and twelfth annual reports of the State Experiment Station, and the reports of the Hatch Experiment Station for the last three years. In the summer of 1895 two plots (one muriate the other sulphate) of each of the following clovers were sown: sweet clover (*Melilotus alba*), mammoth red clover, medium red clover and alsike

clover. Between the crops produced respectively on the muriate and sulphate of potash no marked difference in yield was observed in either 1896 or 1897. It was, however, noticed in 1896 that the clover raised on the sulphate of potash was richer in starch and similar extractive substances, in the case of the mammoth, medium and alsike clovers, than that raised on the muriate, thus making the sulphate clover the more valuable.

Bad Effect of the Muriate.

In August of 1897 the plots were ploughed and all again seeded to the same varieties of clover. Germination was excellent, but within a very few weeks after the young plants appeared it was observed that in the case of the mammoth, medium and alsike varieties the plants were doing very poorly upon the muriate plots. As the autumn advanced, these plants for the most part grew more and more feeble, and many died. The winter was favorable to newly seeded land; but in the spring it was found that a large proportion of the plants upon the muriate plots were dead, in the case of the varieties above named. The sweet clover showed no difference between the two fertilizers. The condition of the clovers upon the sulphate plots was not entirely satisfactory, although far superior to that upon the muriate.

It was decided to sow additional seed upon all the plots without reploughing. Accordingly, on April 2, 4 pounds of seed of the appropriate variety were sown upon each of the plots. The conditions were favorable to germination, and a good stand of young clover was obtained upon all the plots. The sulphate plots gave much the larger yields of clover this season, because they contained a far larger proportion of the older plants from last summer's sowing. At the present time, however, the condition of the clover upon the muriate and sulphate plots is fairly even, for the spring-sown clover has done equally well upon both the potash salts.

This record of facts is made without comment, as without further investigation it appears to be impossible to explain why the summer-sown clover failed on the muri-

ate, while the spring-sown has flourished upon the same plots without reploughing or any change in treatment.

MURIATE *v.* SULPHATE OF POTASH FOR CORN. (FIELD B.)

Two plots in Field B, one muriate and one sulphate, were planted to Sibley's Pride of the North corn, with a view to testing the relative value of these two potash salts for this crop. It will be remembered that these plots have been under the same manurial treatment since 1884. The fertilizers were broadcasted after ploughing, and harrowed in, and the corn was planted on May 30, in drills $3\frac{1}{2}$ feet apart. It was later thinned to 1 foot in the drills. The crop was cut September 9 and husked the middle of October.

Corn on Muriate and on Sulphate of Potash.

MANURING PER ACRE.	Corn (Pounds).	Stover (Pounds).	YIELD PER ACRE.	
			Corn (Bushels).	Stover (Pounds).
Plot 19, { Muriate of potash, 400 pounds, Ground bone, 600 pounds, }	488.5	866	45.8	6,495
Plot 20, { Sulphate of potash, 400 pounds, Ground bone, 600 pounds, }	428.5	652	40.1	4,890

The apparent superiority of the crop raised on the muriate of potash is considerable. During the growth of the crop, as the result of frequent examinations, no such difference was evident; and it is regretted that the moisture test has not been completed in season for this report, as it is felt that there may have been a difference in condition of the two crops when weighed, owing to the very rainy weather of the autumn.

SWEET CLOVER (*Melilotus alba*).

As has been stated under "Muriate *v.* Sulphate of Potash for Clovers," sweet clover occupied two of the plots in Field B. The present is the third successive year that this clover has been grown upon these plots, and the soil appears now to have become thoroughly stocked with the nodular bacteria peculiar to the plant. As reported in 1896, but few of the plants on these plots in that year possessed

bacteria, and only those which did made vigorous growth. The next year, as already reported, about one-half of the plants apparently possessed nodules and made vigorous growth early in the season. Later all seemed to acquire the ability to make use of the atmospheric nitrogen which these nodular bacteria give. The crop of this season has been extremely vigorous from the very first. The rapid growth of this legume in early spring seemed to indicate its possible value as a cover crop for green manuring; and to test this point one square yard (believed to be average) was harvested at each of three different dates, and a determination of dry matter and of nitrogen contained therein was made. The results calculated per acre were:—

DATE.	Height (Feet).	Dry Matter (Pounds).	Nitrogen (Pounds).
June 6, ...	2½	3,661.6	136.8
June 15, ...	3½	3,961.7	130.2
July 10, ...	5½	7,573.0	192.5

The crop was in full bloom at the time the last cutting was made, but it goes on blooming freely for almost the entire summer.

Corn for the silo may here be planted up to the middle of June, with a good prospect of success; and, as will be seen, previous to that date the sweet clover makes a large growth and contains a heavy amount of nitrogen. The amount of this element at the date of the second cutting is equivalent to that contained in about 6 cords of rich manure. To what extent, however, this nitrogen has been taken from the soil, and to what extent from the air, our experiments afford us no means for determining. Kühn has pointed out that the acquisition of atmospheric nitrogen by plants of the clover family takes place most abundantly in the later stages of their growth; and that, if they be ploughed under immature, we can hope for but little gain in that element. Our experiment, then, is not conclusive, as yet, as to the value of this clover as a green manuring crop. Since, however, being sown in the latter part of July

or early in August, it will afford winter protection to the soil and furnish a large growth before late corn planting time, it seems worthy of further trial.

Value for Bees.

As is known to many, this clover furnishes an abundant and long-continued supply of honey. For many weeks the plants in our plots were daily visited by countless myriad bees, and the rate of honey production of those kept near by was very rapid. The honey is of good quality.

High-priced Seed an Obstacle to the Use of Sweet Clover.

The high price at which the seed of this clover is at present offered in our markets constitutes a great obstacle to its use as a green manuring crop. Recognizing this fact, and wishing to determine whether the seed might not be more cheaply offered, our crop of this year was allowed to mature. The sulphate of potash plot (two-fifteenths acre) gave a product of 43.5 pounds and the muriate plot 46.5 pounds of rather poorly cleaned seed. It is true that the season was unfavorable to the ripening of the seed; but the indication of this single experiment is that the species can not be counted upon for a liberal seed product, and that, therefore, the seed must remain high in price.

NITRAGIN, A GERM FERTILIZER.

In connection with my report upon sweet clover, it has been shown that in the early attempts to cultivate this crop but partial success was obtained, because the germs of the appropriate nodular bacteria (microscopic plants, which, growing in nodules upon the roots, give the power of assimilating the free nitrogen of the air) were not present in sufficient numbers. It is there pointed out that, after three years' culture of the sweet clover upon the same plots, these bacteria so multiplied in the soil that complete success with the clover followed. Similar results in the first attempts to cultivate plants of the "pod" family (*Leguminosæ*) in localities where they had not been before grown have many times been observed; and many times, also, has ultimate success crowned the effort to produce the new plant, and for the

reason above alluded to. The attainment of success in this manner, however, requires some few years; and time is precious. Recognizing this fact, an attempt to propagate the bacteria connected with nitrogen assimilation artificially and to put them upon the market was some few years ago made by Professor Nobbe of Tharandt, Germany. The effort was successful, and the product, under the name *Nitragin*, has been offered for the past few years by a German firm with which Professor Nobbe completed arrangements for its production and sale. Full particulars concerning *Nitragin*, and directions for its use, will be found in our eleventh annual report. The unsuccessful results of its trial upon clover in 1897 are published in our last annual report.

The scientific standing of Professor Nobbe is such and the general importance of the subject so great that further trials and with other plants seemed desirable. Accordingly, nitragin for the following species was ordered direct from the makers: crimson clover, red clover, alfalfa, sweet clover, soy bean, vetch and pea.

The experiments are not yet complete, but are being carried out upon poor plain land hired for the purpose, where most of these crops have never been cultivated, as well as upon our own grounds. The plan of the experiment upon the plain land is shown below.

Plan of Nitragin Experiments.

The plots are one-twentieth of an acre each, duly separated by dividing strips. The treatment of the several plots for each crop will be clear from the table: —

Plot 1, no fertilizers. No nitragin.

Plot 2, no fertilizers. Nitragin.

Plot 3, { acid phosphate, 400 pounds per acre. }
 { muriate of potash, 250 pounds per acre. } No nitragin.
 { lime, 1,000 pounds per acre, }

Plot 4, manurial treatment, like Plot 3. Nitragin.

Plot 5, same manures as 3, and, in addition, 180 pounds per acre of nitrate of soda. No nitragin.

The plan upon the home grounds is similar, with two exceptions: (1) The plots are smaller, and (2) there are no plots left unfertilized.

The crops started in the spring upon the "plain" include field peas, alfalfa, alsike clover and common red clover. The peas were harvested early in August. The yields of the several plots were very small, and showed no favorable influence from the nitragin. Of all the other crops, it can be reported to-day that the general condition is poor; that the best condition is to be found in every case upon Plot 5 (supplied with available fertilizer nitrogen), and that the crop upon mineral fertilizers with nitragin (4) appears somewhat better than the corresponding plot (3) without nitragin. Between plots 1 and 2 there appears to be no appreciable difference.

Upon our home grounds the field pea with nitragin gave a slightly better crop on mineral fertilizers alone than on mineral fertilizers without nitragin. Alfalfa upon mineral fertilizers and nitragin now looks better than on the same fertilizers without nitragin. It will be seen, then, that thus far the experiments of this season afford indications that some slight benefit has followed the use of this germ fertilizer.* Of the crops sown in late summer it is as yet too early to report.

FERTILIZERS FOR GARDEN CROPS.

This series of experiments, begun in 1891, was originally intended to test the value for the different garden crops of nitrate of soda, sulphate of ammonia and dried blood as sources of nitrogen; but in the second year it was made to include also a comparison of muriate with sulphate of potash, each used with each of the three nitrogen fertilizers, for the same class of crops. Dissolved bone-black has been applied equally to all the plots from the first. The number of plots and the fertilizers annually applied to each up to the present year are shown in the following table: —

* It may be useful, though this fact has already many times been pointed out, to remark here that a third, and often very satisfactory, method of securing a stock of nodular bacteria consists in taking earth from soil where the crop under trial flourishes, and incorporating a little, as one might fertilizer, with the soil where the new crop is to be grown. This method is now under trial here with alfalfa with soil from Kansas.

Annual Supply of Manurial Substances (Pounds).

Plot 1, . . .	{	Sulphate of ammonia, ...	38
		Muriate of potash, ...	30
		Dissolved bone-black, ...	40
Plot 2, . . .	{	Nitrate of soda, ...	47
		Muriate of potash, ...	30
		Dissolved bone-black, ...	40
Plot 3, . . .	{	Dried blood, ...	75
		Muriate of potash, ...	30
		Dissolved bone-black, ...	40
Plot 4, . . .	{	Sulphate of ammonia, ...	38
		Sulphate of potash, ...	30
		Dissolved bone-black, ...	40
Plot 5, . . .	{	Nitrate of soda, ...	47
		Sulphate of potash, ...	30
		Dissolved bone-black, ...	40
Plot 6, . . .	{	Dried blood, ...	75
		Sulphate of potash, ...	30
		Dissolved bone-black, ...	40

The area of the plots is about one-eighth of an acre each. The fertilizers used supply, at the rates per acre: phosphoric acid, 50.4 pounds; nitrogen, 60 pounds; potash, 120 pounds.

The management of the experiment and results and conclusions are presented in great detail in our eighth, ninth and tenth annual reports, and to these the student of these experiments is referred. It suffices for our present purpose to call attention to the general results up to the end of the year 1897, which are shown below: —

Averages of Garden Crops, 1892 to 1897, inclusive.

Plots.	Spinach, grown Three Years (Pounds).	Lettuce, grown Three Years (Pounds).	Tomatoes, grown Four Years (Pounds).	Beans, grown Three Years (Pounds).	Onions, grown Two Years (Pounds).	Sweet Corn, grown Two Years (Pounds).	Green Peas, grown One Year (Pounds).	Table Beets, grown Two Years (Pounds).
Plot 1, ...	153	37	482	43	111	144	177	255
Plot 2, ...	210	43	707	49	326	179	203	479
Plot 3, ...	182	42	577	50	259	160	281	372
Plot 4, ...	196	63	717	44	221	151	348	425
Plot 5, ...	232	66	790	59	298	143	343	591
Plot 6, ...	149	41	503	51	235	154	307	483

It is important to point out that none of the crops included above has in any year occupied the whole of the area under experiment. Each year we have had some four or five crops, and the areas in each have varied. The above figures are valuable, then, solely as a basis of comparison between the several plots.

Conclusions based on Results up to 1897.

The chief conclusions which seemed justified by the results above given are the following:—

1. Sulphate of potash in connection with nitrate of soda (Plot 5) has generally given the best crop. In those cases where this has not been true, the inferiority of this combination has usually been small. In one case only has it fallen much behind, viz., with sweet corn, a crop which makes much of its growth in the latter part of the season.

2. Nitrate of soda (plots 2 and 5) has in almost every instance proved the most valuable source of nitrogen, whether used with muriate or the sulphate of potash.

3. The combination of sulphate of ammonia and muriate of potash (Plot 1) has in every instance given the poorest crop. This fact is apparently due, as Dr. Goessmann has pointed out, to an interchange of acids and bases leading to the formation of chloride of ammonia, which injuriously affects growth.

The Experiment in 1898.

In the fall of 1897 the plots were ploughed, and rye sown on all (without further manuring) as a cover crop, chiefly to prevent soil washing. The growth on Plot 1 (sulphate of ammonia and muriate of potash) was sickly and feeble, but no particular difference was noticed between the other plots.

Change in Plan.

In view of the fact that market gardeners, in whose interests chiefly these experiments are being carried out, almost invariably use large quantities of stable manure, and employ fertilizers, if at all, simply to supplement the manure, it was decided to make a change in the plan of the experiment, in order that the conditions under which we are working may more nearly conform to those of the average market gardener.

Accordingly, it was decided to apply equal amounts of thoroughly mixed stable manure to each plot, and to use on each, in addition, the same fertilizers as heretofore. Further, in order to have a basis for determining whether the fertilizers should prove in any degree useful, another plot was added, to which manure alone is applied. It was impossible to secure for this purpose a plot of exactly the same shape as the others, and of course it has not had the same history. It is, however, contiguous, and it has the same elevation and similar soil. This plot, which will be called plot 0, has for the past fifteen years received an annual application at the rate of ground bone 400 pounds and muriate of potash 200 pounds per acre. It has been planted yearly with a variety of the newer forage crops. Manure was applied at the rate per acre of twelve cords to all of the seven plots. The manure was applied by measure, but it was also weighed. The table shows the weight applied to each plot and the quantities of plant food which it carried: —

Plots.	Manure (Pounds).	Nitrogen (per Cent.).	Potassium Oxide (per Cent.).	Phosphoric Acid (per Cent.).
Plot 0, ...	6,720	28.8960	10.7520	17.4720
Plot 1, ...	6,977	30.0011	11.1632	18.1402
Plot 2, ...	6,775	29.1325	10.8400	17.6150
Plot 3, ...	7,065	30.3795	11.3040	18.3690
Plot 4, ...	6,617	28.4531	10.5872	17.2042
Plot 5, ...	7,210	31.0030	11.5360	18.7460
Plot 6, ...	6,945	29.8635	11.1120	18.0570
Manure contained, ...	—	.0043	.0016	.0026

Details.

The manure was evenly spread upon the surface April 18–23. The land was ploughed April 27, a thin crop of rye, previously alluded to, being turned under. The fertilizers were applied evenly, broadcast as in previous years, on May 2, and harrowed in. The land was once more harrowed on May 5. Throughout the season all plots received clean culture.

The crops the past season have been : strawberries (Clyde), spinach, lettuce, table beets, tomatoes, cabbage, celery and potatoes ; and, as a second crop, turnips.

Clyde Strawberries. — Three rows were set in each plot. The growth was vigorous and healthy on all plots. Plots 4, 5 and 2 now show a slight superiority over the others, while Plot 0 is the poorest. All are well stocked, in matted rows.

Long Standing Spinach. — Three rows of this crop were planted in each plot May 7. All germinated well, but by June 9 many plants were dying on plots 1 and 4 (sulphate of ammonia and muriate of potash, and sulphate of ammonia and sulphate of potash), while nearly all the plants in these plots appeared yellow and sickly. All the spinach was harvested in two cuttings. The yields in pounds were as follows: Plot 0, 69; Plot 1, $1\frac{1}{4}$; Plot 2, $156\frac{1}{2}$; Plot 3, $77\frac{3}{4}$; Plot 4, $13\frac{1}{2}$; Plot 5, $159\frac{1}{2}$; Plot 6, $73\frac{3}{4}$.

The average yields in pounds produced by the different fertilizers* were : —

Manure alone (Plot 0), ...	88.7
Average of manure and muriate of potash (plots 1, 2 and 3), . .	78.5
Average of manure and sulphate of potash (plots 4, 5 and 6), .	82.3
Average of manure and sulphate of ammonia (plots 1 and 4), .	7.4
Average of manure and nitrate of soda (plots 2 and 5), . . .	158.0
Average of manure and dried blood (plots 3 and 6), ...	75.8

It will be noticed that the muriate of potash plots are inferior to those receiving sulphate of potash, though the difference is small. The sulphate of ammonia plots proved almost an absolute failure, while the dried blood gave a much smaller crop than the nitrate of soda. The most important fact brought out is the marked superiority of the latter as a source of nitrogen for spinach.

Hunson Lettuce. — Two rows of this crop, planted May 7, were grown in each plot, the plants being brought by

* To enable the reader the better to make comparisons, the plots are characterized as "manure and muriate of potash," "manure and sulphate of potash," etc. It should be remembered that dissolved bone-black was applied to all except Plot 0, and that every plot received material supplying both nitrogen and potash as well as phosphoric acid in addition to the manure. For the full list of fertilizers applied to each plot, see page 66.

thinning and resetting to a uniform distance of 1 foot in the rows, except on plots 1 and 4, where a large number of the plants died soon after coming up. In harvesting, the heads of market size were cut from day to day. The total crop in pounds on the several plots was: Plot 0, $179\frac{1}{4}$; Plot 1, 40; Plot 2, $194\frac{1}{4}$; Plot 3, $220\frac{3}{4}$; Plot 4, 135; Plot 5, 219; and Plot 6, $231\frac{1}{4}$.

The average yields, in pounds, produced by the different fertilizers were:—

Manure alone (Plot 0, <i>corrected for area</i>), . . .	230.5
Manure and muriate of potash (plots 1, 2 and 3), . . .	151.7
Manure and sulphate of potash (plots 4, 5 and 6), . . .	195.1
Manure and sulphate of ammonia (plots 1 and 4), . . .	87.5
Manure and nitrate of soda (plots 2 and 5), . . .	206.6
Manure and dried blood (plots 3 and 6), . . .	226.0

The manure alone gave, as will be seen, a larger yield than any of the plots to which fertilizers as well as manure were applied. The only point clearly indicated is the apparent highly injurious effect of the sulphate of ammonia, particularly where used with the muriate of potash.

Dewing's Blood Turnip Beet.—Six rows of this crop, planted May 7, were grown in each plot. In plots 1 and 4 most of the plants soon became weak and sickly and many died, and there were not enough to restock to the uniform distance of 4 inches in the row, to which all the other plots were brought by thinning and resetting where needed. The few plants in plots 1 and 4 which survived until about July 1 then appeared to recover their vigor, and grew very rapidly. The yields of roots and tops were as shown below:—

PLOTS.	Beets (Pounds).	Tops (Pounds).
Plot 0, ...	340	440
Plot 1, ...	80	160
Plot 2, ...	440	570
Plot 3, ...	365	515
Plot 4, ...	260	470
Plot 5, ...	460	490
Plot 6, ...	325	335

The average yields in pounds per plot were as follows:—

	Roots.	Tops.
Manure alone (Plot 0, corrected), ...	374.7	484.9
Manure and muriate of potash (plots 1, 2 and 3), ...	295.0	415.0
Manure and sulphate of potash (plots 4, 5 and 6), ...	348.3	431.7
Manure and sulphate of ammonia (plots 1 and 4), ...	170.0	315.0
Manure and nitrate of soda (plots 2 and 5), ...	450.0	530.0
Manure and dried blood (plots 3 and 6), ...	345.0	425.0

The general result here is similar to that with spinach; *i.e.*, muriate is inferior to the sulphate of potash; nitrate of soda is the best source of nitrogen; and sulphate of ammonia shows itself to have been actually injurious, particularly so with muriate of potash.

Dwarf Champion Tomato.—Two rows were set in each of the original six plots and three in Plot 0, the plants, purchased of the Horticultural Department, being rather small and uneven. The crop was picked as it ripened until September 23, when the balance of the fruit was picked green. The weights of ripe and of green fruit in pounds per plot are shown below: *—

PLOTS.	Ripe Fruit.	Green Fruit.
	Lbs. oz.	Lbs. oz.
Plot 0, ...	422 3	179 8
Plot 1, ...	387 7	223 0
Plot 2, ...	501 4	160 0
Plot 3, ...	328 2	178 0
Plot 4, ...	430 6	181 0
Plot 5, ...	413 1	84 8
Plot 6, ...	405 4	181 8

The averages of ripe fruit and total yield in pounds per plot were as shown in the table:—

* The record of one day's picking of ripe fruit was lost, but this does not change the relative standing of the plots.

	Ripe Fruit.	Total.
Manure alone (Plot 0, corrected for area), ...	361.9	515.7
Manure and muriate of potash (plots 1, 2 and 3), ...	405.6	592.6
Manure and sulphate of potash (plots 4, 5 and 6), ...	416.2	565.2
Manure and sulphate of ammonia (plots 1 and 4), ...	408.9	610.9
Manure and nitrate of soda (plots 2 and 5), ...	457.2	579.4
Manure and dried blood (plots 3 and 6), ...	366.7	546.4

The differences brought out by these averages are much smaller than in the case of the spinach and beets, but are in the same direction for ripe fruit; *i.e.*, sulphate of potash gives somewhat better returns than muriate, and nitrate of soda gives the largest yield of any of the sources of nitrogen. It is noteworthy that the sulphate of ammonia does not appear to have injuriously affected this crop. This is perhaps due to the fact that the tomato is not set until about the first of June, and makes most of its growth when the season is well advanced. The crops shown to have been injured by the sulphate of ammonia, spinach and beets, are sown early, and make most of their growth before the season is far advanced.

Foller's Drumhead Cabbage.—Two rows in each of the original six plots and three in Plot 0 were grown. The seed was planted May 23, in hills, and later thinned to one in each hill, those destroyed by maggots being replaced. Owing to the unusually hot season, the crop was well grown by September 1, and numerous heads were beginning to crack. They were harvested as they matured, September 8 to November 5. The yield in pounds of heads, practically all well filled and hard, was as follows: Plot 0, 729; Plot 1, 720; Plot 2, 780; Plot 3, 710; Plot 4, 755; Plot 5, 744; and Plot 6, 651.

The average yields in pounds per plot were as follows:—

Manure alone (Plot 0, corrected), ...	624.9
Manure and muriate of potash (plots 1, 2 and 3), ...	736.7
Manure and sulphate of potash (plots 4, 5 and 6), ...	716.7
Manure and sulphate of ammonia (plots 1 and 4), ...	737.5
Manure and nitrate of soda (plots 2 and 5), ...	762.0
Manure and dried blood (plots 3 and 6), ...	680.5

Here we find the fertilizers have apparently produced a moderate increase in crop. The differences between them are far less marked than in the case of most of the other crops grown this year. The nitrate of soda appears to have been the best source of nitrogen for the cabbage.

Early Maine Potatoes.—The seed planted was grown in the State of Maine. It was treated with corrosive sublimate solution, for prevention of scab, and sun-sprouted. Before planting, the tubers were cut to pieces with two eyes each. Three rows per plot (4 on Plot 0) were grown. The seed was planted on May 9 in rows 3 feet apart, the pieces being dropped 1 foot apart in the rows. Ordinary thorough culture was given until the vines covered the ground. The vines were sprayed with Bordeaux mixture (first on June 7) to repel the flea beetle. They were sprayed with sufficient frequency to keep the vines well covered with the mixture until the middle of August, the last application being made August 8. The Bordeaux mixture was applied nine times in all, frequent re-application being necessary, on account of the numerous heavy rains. The vines were slightly attacked by blight about the middle of July; but later in August new shoots were thrown out from the axils of the lower leaves, making a healthy growth, which remained green until very late in September. The tubers averaged large and smooth, and showed very little rot when dug. A few weeks after storing there were a few more decayed tubers. The yield in pounds was as follows:—

Plots.	Merchantable Tubers.	Small Tubers.
Plot 0, ...	441.5	41.0
Plot 1, ...	449.0	40.0
Plot 2, ...	426.0	40.0
Plot 3, ...	409.0	62.5
Plot 4, ...	550.0	35.0
Plot 5, ...	482.0	31.5
Plot 6, ...	482.0	51.5

Yield per Acre (Bushels).

Plots.	Merchantable Tubers.	Small Tubers.
Plot 0, ...	381.5	35.4
Plot 1, ...	447.2	35.8
Plot 2, ...	381.7	35.8
Plot 3, ...	366.5	56.0
Plot 4, ...	492.8	31.4
Plot 5, ...	431.9	28.3
Plot 6, ...	431.9	46.1

The averages calculated to show the relative effect of the different fertilizers are given below in pounds per plot:—

Plots.	Merchantable Tubers.	Small Tubers.
Manure alone (Plot 0, corrected), ...	425.7	39.5
Manure and muriate of potash (plots 1, 2 and 3), ...	444.7	47.5
Manure and sulphate of potash (plots 4, 5 and 6), ...	504.7	39.3
Manure and sulphate of ammonia (plots 1 and 4), ...	524.5	37.5
Manure and nitrate of soda (plots 2 and 5), ...	454.0	35.8
Manure and dried blood (plots 3 and 6), ...	445.5	57.0

It becomes evident from a study of these figures that the fertilizers proved moderately beneficial to this crop, and that the sulphate of potash is superior to the muriate. The various sources of nitrogen rank in the order, sulphate of ammonia, nitrate of soda and dried blood, the first giving a much larger average crop than either of the others. It seems further important to point out that the combination sulphate of ammonia with muriate of potash, which has proved both in previous years and in this year so fatal to most crops, has given a fine crop of potatoes, at the rate of 447 bushels to the acre, the second in rank among the seven plots. No explanation can be offered, beyond that already suggested in the case of tomatoes, viz., that the potato has a much longer growing season than the crops doing so very poorly on this combination of fertilizers. It

seems reasonable to suppose that, as the season advances, the injurious ammonium chloride formed at first is either washed out of the soil or destroyed by further chemical changes. This question will be made a matter of further study.

The spraying with Bordeaux mixture, although necessarily nine times repeated on account of the unusual number of heavy rains, must be considered to have been profitable, as the yield was very heavy, while in general the crop this year was light where spraying was not practised.

Giant Pascal Celery.—Two rows were grown in each plot; the plants, large and well grown, were set 1 foot apart in rows 5 feet apart on July 19. Banking began September 29, and the crop was put into the cellar in good condition on November 4. The growth on plots 0, 1 and 4 was fair; on the other plots, excellent. There was considerable rust on Plot 0, while there was little or none on the other plots. The weights in pounds of the plants (including roots and a little earth) were as follows: Plot 0, 443; Plot 1, 328; Plot 2, 478; Plot 3, 478; Plot 4, 348; Plot 5, 568; Plot 6, 488.

The calculated averages will not be given until the crop is blanched, since the earth, of necessity left adhering to the roots of the plants as put into the cellar, is an element of uncertainty. It may be of interest to state that these averages indicate little if any increase which can be attributed to the fertilizers.

White Egg Turnips.—This crop followed spinach, lettuce and table beets, without further manuring. The land was reploughed and fitted and the seed sown on July 28, in rows 14 inches apart. Soon after sowing a heavy shower caused some washing across the plots, which was particularly injurious on Plot 0. The crop was harvested November 8 and 9, and was of excellent quality. The yields in pounds are shown in the following table:—

Plots.	Roots.	Tops.
Plot 0, ...	580.0	185
Plot 1, ...	702.0	348
Plot 2, ...	753.5	315
Plot 3, ...	735.0	315
Plot 4, ...	938.0	335
Plot 5, ...	655.0	260
Plot 6, ...	690.0	215

The calculated averages in pounds are given in the following table:—

	Roots.	Tops.
Manure alone (Plot 0, corrected), ...	688.3	219.7
Manure and muriate of potash (plots 1, 2 and 3), ...	730.3	326.0
Manure and sulphate of potash (plots 4, 5 and 6), ...	761.0	270.0
Manure and sulphate of ammonia (plots 1 and 4), ...	820.0	341.5
Manure and nitrate of soda (plots 2 and 5), ...	704.3	287.5
Manure and dried blood (plots 3 and 6), ...	712.5	285.0

The fertilizers are shown to have been moderately beneficial, there is not much difference between the two potash salts, and the sulphate of ammonia gives a much better crop than either of the nitrogen fertilizers. This is not strange, in view of these facts: (1) the plots to which this had been applied had produced but very small first crops, while the others had yielded heavily; and (2) that the turnips made their growth so late in the season that the injurious compounds often formed by this salt had become dissipated, or destroyed by further chemical changes.

EXPERIMENTS IN MANURING GRASS LANDS.

The system of using wood ashes, ground bone and muriate of potash, and manure in rotation upon grass land has been continued. We have three large plots (between two and three acres each) under this treatment. Under this system each plot receives wood ashes at the rate of 1 ton

per acre one year; the next year, ground bone 600 pounds and muriate of potash 200 pounds per acre; and the third year, manure at the rate of 8 tons. The system is so planned that each year we have one plot under each manuring. The manure is always applied in the fall, the other materials early in the spring; this year April 8 and 9.

Plot 1, which this year received bone and potash, gave a yield at the rate of 5,137 pounds of hay and 2,370 pounds of rowen per acre. Plot 2, which received ashes, yielded 4,602 pounds of hay and 2,142 pounds of rowen. Plot 3, which was dressed with manure in the fall of 1897, yielded 5,233 pounds of hay and 2,823 pounds of rowen per acre. This field has now been ten years in grass, and during the continuance of the present system of manuring (since 1893) has produced an average product (hay and rowen both included) at the rate of 6,808 pounds per acre. The plots when dressed with manure have averaged 7,211 pounds per acre; when receiving bone and potash, 6,671 pounds per acre; and when receiving wood ashes, 6,541 pounds per acre.

VARIETY TESTS.

Our work in testing varieties this year has been confined to testing the potato. With this it has been extensive. The tests have been of two sorts; (1) a preliminary test with varieties grown for the first time; and (2) a test of the best twenty-five varieties, as indicated by the trial of last year.

1. *Preliminary Test.*—As has been stated in my previous reports upon variety work with the potato, I consider several years' trial necessary to the formation of a judgment. The seed of new varieties as they are brought out must of necessity come from many widely separated localities. Such seed is unfit to serve as a basis for comparison, with the object of determining the relative merits of varieties, as it is well known to many and quite generally admitted that the place where any given variety of seed potatoes is produced may greatly influence its product. Newly obtained varieties must also of necessity have been subjected to widely variant conditions of handling, preservation and

transportation, and all these factors influence product. For all these reasons our practice is to obtain but a small quantity of seed of new varieties as they come to our attention, and to plant this for the purpose of raising seed for the next year's trial, which shall have been produced under similar conditions and similarly handled. This constitutes our "*preliminary test.*"

This test the past season included seventy-five varieties, obtained from almost as many seedsmen, scattered all over New England, the middle and central States and Canada. The seed of all was treated with corrosive sublimate solution and sun-sprouted. It was then cut to pieces of two good eyes each, and planted one piece to a foot, in rows 3 feet apart. The soil was a good medium loam, naturally well drained. The fertilizers used in pounds per acre were : —

Nitrate of soda,		240
Acid phosphate,		400
Sulphate of potash (high grade),		250
Tankage, .		240
Dried blood,		100

These materials were mixed just before using, and scattered broadly in the drills before dropping the seed. The planting took place May 11 and 12. All varieties were injured by hot, dry weather, which came just as the tubers were forming, and by blight, although sprayed with Bordeaux mixture six times between June 13 and August 2. The varieties on which blight was first noticed were Salzer's Earliest, Bliss Triumph, King of the Earliest and Lincoln, — July 24 and 25. All other varieties showed blight between July 28 and August 1, and to about an equal degree. It is thought that no varieties blighted long before they were mature ; but, nevertheless, the blight undoubtedly greatly reduced the yields. Owing to the blight, the period of apparent ripening of all varieties was nearly the same, viz., August 27 to September 8. The potatoes were dug late in September. The average number of sets for each variety was about forty, and to this number the yield of

all has been corrected. Such correction, in our experience, always proves unduly favorable to the varieties of which we have the least seed. Our effort has always been to obtain just three pounds of each variety; but sometimes we are unable to obtain so much, or it may be that some tubers obtained prove unfit to plant, owing to bruising or decay.

The yield this year has varied from 8.5 to 46.7 pounds of merchantable tubers for 40 sets.* Six varieties have given a yield of 40 pounds or above of merchantable tubers from 40 sets, viz., Ford's No. 31, 46.7; Early Minnesota, 44.7; Champion of the World, 41.8; Burr's No. 1, 40.8; and American Wonder and Early Dawn, 40 each. Eight varieties gave under 20 pounds from 40 sets, viz., Lady Finger, 8.5; Mayflower, 13.9; Salzer's Earliest, 14.2; Potentate, 15.3; Mills's Long Keeper, 16; Livingston's Pinkeye, 16.8; and King of the Earliest and White Beauty, 18.5 each.

2. *Test with Twenty-five Varieties (the Best of Last Season).*—The seed of these varieties, it will be understood, was all of our own growing, and was of most excellent quality. It was prepared for planting as above described, and was planted upon similar soil and similarly manured. One hundred sets of each variety were planted on May 13. These varieties were sprayed six times, as were those in the preliminary test. They, however, showed considerable blight, and doubtless gave diminished yields because of this affliction. The yields have been calculated to 40 sets, to make them comparable with the varieties in the other test. These are shown in the table following:—

* Forty pounds for 40 sets corresponds to a yield of 242.4 bushels per acre.
Thirty pounds for 40 sets corresponds to a yield of 181.8 bushels per acre.
Twenty pounds for 40 sets corresponds to a yield of 121.2 bushels per acre.

Variety Test of Potatoes. Yield in Pounds from 40 Sets.

VARIETY.	Merchantable Tubers.	Small Tubers.
Beauty of Hebron, ...	33.40	7.00
Bliss's Triumph, ...	20.40	9.60
Carmen No. 1, ...	23.40	12.80
Dakota Red, ...	19.20	10.80
Dutton's Seedling, ...	32.20	15.20
Early Maine, ...	21.20	2.80
Early Rose, ...	28.00	9.00
Early Sunrise, ...	26.40	10.80
Empire State, ...	12.40	7.60
Enormous, ...	36.80	4.20
Fillbasket, ...	37.60	5.60
Late Puritan, ...	26.80	9.60
Money Maker, ...	26.60	7.40
New Satisfaction, ...	26.60	6.00
Prolific Rose, ...	23.20	8.00
Restaurant, ...	34.80	7.60
Rochester Rose, ...	29.60	8.80
Rose No. 9, ...	34.00	5.20
Sir William, ...	26.80	6.20
State of Maine, ...	34.00	4.80
Thorburn, ...	35.80	6.40
Uncle Sam, ...	28.40	3.80
Vanguard, ...	31.80	9.00
White Elephant, ...	40.20	8.00
Woodbury's White, ...	35.90	5.00

Last year the eleven best varieties ranked in yield of merchantable tubers in the following order: Rose No. 9, Restaurant, Woodbury's White, Bliss's Triumph, Prolific Rose, Empire State, Early Maine, Dakota Red, Sir William, Early Rose and Beauty of Hebron. All of these then gave a product at the rate of more than 220 bushels of merchantable tubers per acre.

This year the relative rank, as will be seen, is quite different. The yields are in general much lower. The results of this year, however, owing to the blight, cannot be re-

garded as affording a reliable index to the relative merits of the varieties. Their publication, however, serves to illustrate how almost impossible it is, in the making of such tests, to establish the relative merits of varieties. As I have remarked in previous reports, it is significant that the old standard, Beauty of Hebron, is once more one of the first ten varieties.

Identical Varieties under Different Names.

As far as we are able to judge, there is no difference between King of the Earliest and Early Ohio; Salzer's Earliest and Bliss's Triumph; Mills's Banner and Livingston's Banner; while White Beauty and Cambridge Russet differ but very slightly, the latter having a slightly more russetted skin than the former.

Test of Seed of the Same Variety from Different Localities.

In order to test the soundness of the *a priori* conclusion that, to make the results of a variety test comparable for the purpose of determining relative merits, the seed of all should have been produced in the same locality and handled in all respects alike, an experiment was carried out with two of the old standard sorts, — Beauty of Hebron and Early Rose, — with seed of each from a considerable number of sources. The seed of the former came from eight different producers; that of the latter, from six. The methods pursued in seed preparation, soil, manuring, spraying, etc., were in all respects as in the variety test.

Comparison of Seed Potatoes from Different Localities. Yield in Pounds of 40 Sets.

SOURCE OF THE SEED.	VARIETIES.			
	BEAUTY OF HEBRON.		EARLY ROSE.	
	Merchant- able.	Small.	Merchant- able.	Small.
Home grown, ...	30.0	2.5	25.0	2.9
Guelph, Ontario, D. of C., ...	32.3	1.8	—	—
Pennsylvania grown, Dreer, ...	24.5	3.3	27.5	3.5
James J. H. Gregory, Marblehead, Mass.,	35.5	2.5	—	—
Cornell Experiment Station, Ithaca, N.Y.,	29.3	2.5	31.0	2.0
Wisconsin, Olds Seed Company, . . .	26.0	4.5	—	—
Maine, A. H. Weeks Company, ...	33.3	2.8	—	—
Dibble Seed Company, N. Y., ...	26.5	3.8	32.5	2.0
Minnesota, Farmer Seed Company, . .	—	—	21.0	3.8
Kansas, F. Barteldes & Co., ...	—	—	20.0	7.8

The range of variation in yield, as will be seen, is large, amounting to almost 50 per cent. in the yield of merchantable tubers for the Beauty of Hebron and to rather over 50 per cent. for the Early Rose. In view of this wide difference in the yield of the same variety, it must be admitted that variety tests in which the seed is brought together from many sources can have but a doubtful value.

The extent of the variation in the type of the potatoes grown in this test was considerable, so great, indeed, as to make it doubtful whether in all cases the seed was true to name, although obtained from the most reliable parties in every instance. The extent of the variation is in part shown in the table below, in which each lot is compared with the crop from our home-grown seed of the same variety:—

Potatoes.—Comparison of Crops, Seed from Different Sources.

ORIGIN OF THE SEED.	Shape.	Color.	Size.	Eyes.
<i>Beauty of Hebron.</i>				
Home grown, . . .	Long, elliptical, slightly flattened, tapering strongly towards tip.	Light flesh, mottled with darker shades.	Medium,	Medium, rather deep.
J. J. H. Gregory, . . .	Same, . . .	Same, . . .	Same, .	Smaller, less deep.
Dreer, Pennsylvania, .	Shorter, . . .	Same, . . .	Larger, .	Same.
Olds Company, Wisconsin.	Oval, slightly flat, same at both ends.	Lighter, . . .	Smaller,	Small.
Weeks Company, Maine.	Same, . . .	Same, . . .	Larger, .	Less deep.
Cornell Experiment Station.	Same, . . .	Light, bright pink,	Larger, .	Smaller.
Guelph, Ontario, Experiment Station.	Same, . . .	Same, . . .	Same, .	Same.
Dibble Company, N. Y.,	Same, . . .	Lighter, . . .	Same, .	Same.
<i>Early Rose.</i>				
Home grown, . . .	Long, flattened, tapering towards seed end, curved.	Light pink, bright pink at seed end.	Medium,	Medium large.
Dreer, Pennsylvania, .	Broader, more compact.	Lighter, . . .	Same, .	Same.
Farmer Company, Minnesota.	Much broader, less curved.	Same, . . .	Smaller,	Same.
Cornell Experiment Station.	Longer, more curved.	Same, . . .	Larger, .	Same.
Kansas, Barteldes & Co.,	Broader, more like Hebron.	Same, . . .	Same, .	Smaller, more shallow.
Dibble Company, N. Y.,	Same, . . .	Same, . . .	Larger, .	Large, shallow.

Individual Variation, Tubers of the Same Variety.

In view of the frequently reported tests of varieties in which some two or three tubers only of each are used, it was thought best to carry out an experiment to determine if possible the extent to which the product of single tubers will vary when grown under conditions as favorable as possible to uniformity of yield. As a preparation for this test, tiles two feet in diameter and four feet long were set into the ground in a single row, the distance between them being about two and one-half feet. To insure equal drainage conditions, a drain tile was laid at about the level of the lower edge of the tile, being given just enough pitch to carry off water. The plot of land in which the tiles were set was surrounded with drain tile, to prevent the ingress of soil water from outside. This plot had been uniformly manured for many years, so that the subsoil conditions below the tiles must have been practically uniform. The plots were set so that the surface water from outside was excluded, but the earth outside was brought to within about one inch of the upper edge.

These tiles so set were filled to within one foot of the top with carefully mixed subsoil, consisting of a very fine sand, this subsoil being settled by the liberal use of water. After this subsoil had thoroughly settled and somewhat dried, equal weights of carefully mixed medium loam were put into each tile, the quantities being sufficient to fill them. The amount used was two hundred and twenty-five pounds for each tile. Conclusive evidence that the work was well and uniformly done is afforded by the fact that the earth in the several tiles remained at practically uniform height throughout the season.

With the upper four inches in depth of soil in these tiles were most carefully mixed the fertilizers applied, precisely the same weights as determined by chemical balances to each tile. The materials used supplied per tile and at the rate per acre as follows : —

MATERIALS USED.	Per Tile (Grams).	Rate per Acre (Pounds).
Nitrate of soda, ...	8.07	250
Dried blood, ...	3.23	100
Tankage, ...	8.07	250
Acid phosphate, ...	12.92	400
Sulphate of potash (high grade), ...	9.69	300

This fertilizer was applied May 9, and the seed was planted the same day. The variety was Carmen No. 1. The tubers selected were uniform in form, weight and all external characteristics, as far as it was possible to obtain such. The weights of the tubers were as follows: No. 1, 160 grams; No. 2, 135 grams; No. 3, 160 grams; No. 4, 140 grams; No. 5, 135 grams; No. 6, 140 grams; No. 7, 140 grams; No. 8, 140 grams. The first seven tubers were treated with corrosive sublimate solution, and sun-sprouted; No. 8 was not treated. Each tuber was cut to exact halves by weight, and the number of eyes on each half reduced to five in the same part of the tuber. The tubers were all typical of the variety, and all were entirely free from scab, but there had been a few scabbed potatoes in the crop from which they came. They were all planted face downward at the same depth, the halves of tuber No. 1 in tiles 1 and 2, the halves of tuber No. 2 in tiles 3 and 4, and so on,—and finally one-half of tuber No. 8 in tile 15. They all came up in good season, but somewhat irregularly, May 26 to May 28. They were most carefully cultivated by hand, kept entirely free from weeds and from bugs by hand pulling and picking. Bordeaux mixture was applied six times, June 6 to July 25. There was practically no injury from either flea beetle or blight. The vines in different tiles showed quite different minor characteristics, and ripened unevenly, September 20 to October 1, when the crop was harvested. At that time there was a very little yellowish-green color on part of one stalk in tile 9 and on one entire stalk in tile 8. All leaves had for some time been dead. The yields and remarks are given in the table: —

Yield of Different Tubers, Carmen Potato.

No. of TUBER.	Title.	Number of Tubers.	Weight (Kilograms).*	Remarks.
Tuber No. 1, . . .	{ 1 2	10 14	1.470 1.520	
Tuber No. 2, . . .	{ 3 4	14 11	1.300 1.340 }	One scabby.
Tuber No. 3, . . .	{ 5 6	15 10	1.440 1.440 }	Several slightly scabby.
Tuber No. 4, . . .	{ 7 8	12 8	1.180 1.330 }	Small amount of scab.
Tuber No. 5, . . .	{ 9 10	17 15	1.440 1.820 }	A very little scab.
Tuber No. 6, . . .	{ 11 12	19 9	1.460 1.340 }	A little scab.
Tuber No. 7, . . .	{ 13 14	13 14	1.240 1.450 }	A little scab.
One-half of Tuber No. 8, .	15	16	1.320	Considerable scab.

* The kilogram equals almost exactly 2.2 English pounds.

The above weights were taken after the tubers had been carefully washed and dried. They showed a range of variation amounting between halves to a little over 37 per cent., and between tubers of about 22 per cent. The differences in number and size of tubers are equally striking. In view of these facts, I submit that variety tests of potatoes upon a small scale can have but a small value for determining the probable relative yield of varieties.

POULTRY EXPERIMENTS.

The experiments with poultry completed since our last annual report were begun in the late fall of 1897, and extended through the winter of 1897 and 1898, and a part of them through the past summer and into the fall. The points upon which these experiments were designed to afford information are the following:—

1. Effect upon egg-production of the use of condition powders.

2. Comparative value for egg-production of flesh or animal meal and cut fresh bone.

3. Comparison for egg-production of a wide nutritive ration with a narrow; or, in other words, of a ration in

which corn meal and corn were prominent with one in which these feeds were replaced wholly or in large part with more nitrogenous foods, such as wheat middlings, gluten feed, wheat and oats.

4. The influence of the presence of a cock with the hens upon egg-production.

General Conditions.

In all these experiments pullets purchased in Plymouth County and reaching us about the middle of October were used. These pullets were well-bred Barred Plymouth Rocks, not fancy stock (*i. e.*, as to feather), but bright, healthy stock, hatched in April. These pullets were evenly divided into lots of twenty each, being matched in sets of two lots as closely as possible. Each lot occupied a detached house, including laying and roosting room ten by twelve feet and scratching shed eight by twelve feet, with the run of large yards of equal size whenever weather permitted. The winter tests began December 12 and ended April 30. The latter part of March a few hens were removed from each house for sitters, the same number from each. Egg records of the separate lots were kept from the time laying began to the time of beginning experiments, for the purpose of affording an index as to the equality or otherwise of the matched pairs of lots. The hens were all marked with leg bands, as a precautionary measure for the purpose of identification in the case of accidental mixture of fowls.

All the meals and the cut clover were given in the form of a mash, fed early in the morning. This was mixed the night before with boiling water until January 8, and fed at the temperature of about 70° F. After January 8, the mashes were mixed with boiling water in the morning, and fed hot. At noon a few oats were scattered in the straw with which the scratching sheds were littered. At night the balance of the whole grain was fed (also by scattering in the straw) one hour before dark. The fowls were given what whole grain they would eat up clean. Water, shells and artificial grit were kept before the fowls at all times. About twice a week a small cabbage was given to each lot of fowls, this, like all other food, being weighed. The eggs from each

lot were weighed weekly. The fowls were all weighed once each month.

No male birds were kept in any of the pens in the winter experiments, nor, indeed, in any except where the influence of the cock was the subject of experiment. Sitters, except those taken out, above alluded to, were confined in a coop until broken up, being meanwhile fed like their mates.

The prices per hundred weight for foods, upon which financial calculations are based, are shown below: —

Wheat, ...	\$1 75
Oats, ...	1 00
Wheat bran, ...	60
Wheat middlings, ...	75
Gluten feed, ...	2 00
Animal meal, ...	2 00
Cut clover rowen, ...	1 50
Cabbage, ...	25
Cut bone, ...	2 00
Gluten meal, ...	80
Corn meal, ...	85
Corn, ...	85

Composition of Foods (Per Cent.).

KIND.	Moisture.	AIR DRY FOOD CONTAINS —				
		Ash.	Protein.	Fibre.	Extract.	Fat.
Whole wheat, ...	10.51	1.85	12.64	2.55	71.01	1.44
Whole oats, ...	8.06	3.21	11.96	11.64	61.48	3.65
Cut clover rowen, ...	9.80	7.36	17.88	22.18	39.70	3.08
Wheat middlings, ...	9.25	4.63	17.52	9.91	53.11	5.58
Animal meal, ...	5.06	39.26	37.66	1.01	5.56	11.45
Whole corn, ...	12.11	1.31	9.55	1.90	71.26	3.87

KIND.	Moisture.	DRY MATTER CONTAINS —				
		Ash.	Protein.	Fibre.	Extract.	Fat.
Bran, ...	12.72	6.96	18.01	11.65	57.92	5.46
Gluten feed, ...	9.10	0.92	24.59	7.17	63.43	3.89
Corn meal, ...	13.43	1.46	11.01	1.96	81.44	4.13
Cabbage, ...	89.45	7.94	25.69	9.31	54.76	2.30
Cut bone, ...	26.29	21.50	20.62	—	—	31.38
Gluten meal, ...	8.77	1.50	37.64	3.87	54.59	2.40

1. *Effect of Condition Powder upon Egg-production.*

Each coop contained twenty pullets at the beginning of the experiment; the fowls in the no condition-powder coop weighing 103 pounds, and having laid, November 18 to December 12, 46 eggs; the fowls in the condition-powder coop weighing 97 pounds, and having laid 14 eggs. The rations of the two lots of fowls were the same, except to the morning mash of one lot was added condition powder to the full amount recommended by makers; viz., 3 scoops (provided for measuring) heaping full. This amount of condition powder was enough to make the mash several shades darker than the one without it, and to impart a strong odor. Being mixed sometimes in the room where milk was standing, it imparted a flavor to butter made therefrom which was recognized by our expert butter maker, who knew nothing concerning its use, and who worked in rooms a quarter of a mile distant, to which the milk was taken. The pen receiving the powder consumed during the winter four two-pound cans of it, costing at retail \$4.

Both lots of fowls were healthy throughout the entire test. Two fowls were stolen from the lot receiving no condition powders on the night of March 27. One soft-shelled egg was laid by a fowl receiving condition powder. The tables give all details necessary to a comparison of the results: —

Foods consumed, Condition-powder Experiment.

KINDS OF FOOD.	AMOUNT.	
	Condition Powder.	No Condition Powder.
	Lbs. oz.	Lbs. oz.
Wheat, ...	269 0	250 0
Oats, ...	155 0	152 0
Bran, ...	44 0	44 8
Middlings	44 0	44 8
Gluten feed, ...	44 0	44 8
Animal meal, ...	52 0	52 8
Clover, ...	43 0	44 8
Cabbage, ...	15 15	15 3

Average Weights of the Fowls (Pounds).

DATES.	Condition Powder.	No Condition Powder.
December 12, ...	4.85	5.15
January 31, ...	5.21	5.41
February 25, ...	5.44	5.53
March 30, ...	5.25	5.48
April 30, ...	5.11	4.88

Eggs per Month (Number).

MONTHS.	Condition Powder.	No Condition Powder.
December, ...	28	59
January, ...	90	66
February, ...	86	101
March, ...	217	238
April, ...	298	291
Totals, ...	719	745

Condition Powder for Egg-production (December 12 to April 30).

	Condition Powder.	No Condition Powder.
Hen days, ...	2,751	2,656
Gross cost of food, ...	\$8 91	\$8 59
Cost per hen day, ...	\$0 0032	\$0 0032
Total number of eggs, ...	719	745
Cost per egg, not including powder, ...	\$0 0124	\$0 0115
Cost per egg, including powder, ...	\$0 0180	\$0 0115
Eggs per hen day, ...	.26+	.28+
Total weight of eggs (pounds), ...	83.08	90.80
Average weight of eggs (ounces), ...	1.96	1.95
Dry matter to produce 1 egg (pounds), ...	.82	.77
Dry matter consumed per hen day (pounds), ...	.22—	.22—
Nutritive ratio, ...	1:4.6+	1:4.6—
Slitters, ...	8	14

Eggs from both lots of fowls were tested under numbers by two families. One family reports no difference; the other found the eggs from the hens not getting the powder "much preferable" to the others.

Conclusion.

A study of the figures showing results shows that the hens not getting the condition powder laid more eggs, of practically the same average weight. The food required to produce a single egg was less, and the cost was very materially less. The average weight of the fowls not getting the powder at the close of the experiment was about one-quarter of a pound less than that of the other.

We have now carried through three experiments to test the value of condition powder for egg-production. The differences have in every case been small. In favor of the condition powder we have one experiment, against it we have two experiments. It is not, however, my disposition to claim that the powder is injurious, but simply *that it is not beneficial*. This the four experiments, carried out with the utmost fairness and with every care, certainly prove. *In the light of these results, it is believed that poultry keepers throw away money expended for condition powder.*

2. *Animal Meal v. Cut Bone for Egg-production (December 12 to April 30).*

In this experiment there were nineteen pullets in each house when the experiment began. Those in the animal-meal house weighed 101.5 pounds, and had laid, November 8 to December 12, 82 eggs. The pullets in the cut-bone coop weighed 101.25 pounds, and had laid 41 eggs.

In the morning mash of one lot one part animal meal to five parts total dry materials was used; in the mash of the other lot, the same proportion of fresh-cut bone was mixed. The large, flat bones, comparatively free from meat or fat, were used.

In the animal-meal coop the health of the birds was good, but one fowl being out of condition in any way. She be-

came sick about April 1, and was killed, as she seemed to be growing gradually worse, on April 10. The nature of the trouble was unknown. Almost from the first, bowel troubles were not uncommon in the cut-bone coop. Two fowls died (December 23 and January 11) after short illness. On April 11 one hen was found with a disjointed leg, and she was killed. The animal-meal coop laid three soft-shelled eggs; the other, two.

The bone fed amounted to only .27 ounce per hen daily. One-half ounce and over is the usual recommendation by writers upon the subject. We find it impossible to feed so largely without serious bowel trouble.

Foods consumed, Animal Meal v. Cut Bone.

KINDS OF FOOD.	Animal Meal.		Cut Bone.	
	lbs.	oz.	lbs.	oz.
Wheat, ...	256	0	262	0
Oats, ...	143	0	145	0
Bran, ...	44	8	39	0
Wheat middlings, ...	44	8	39	0
Gluten feed, ...	44	8	-	
Gluten meal, ...	-		39	0
Animal meal, ...	44	8	-	
Cut bone, ...	-		40	0
Clover rowen, ...	44	8	39	0
Cabbage, ...	19	3	18	8

Average Weights of the Fowls (Pounds).

DATES.		Animal Meal.	Cut Bone.
December 12,		5.34	5.38
January 31,		5.64	5.66
February 25,		5.66	5.88
March 30,		5.09	5.27
April 30,		5.06	5.53

Eggs per Month (Number).

MONTHS.	Animal Meal.	Cut Bone.
December, ...	63	57
January, ...	92	83
February, ...	184	120
March, ...	263	259
April, ...	210	209
Totals, ...	812	728

Animal Meal v. Cut Bone for Egg-production.

	Animal Meal.	Cut Bone.
Total number of eggs, ...	812	723
Hen days, ...	2,561	2,331
Gross cost of foods, ...	\$8 45	\$8 29
Cost per egg, ...	\$0 0104	\$0 0114
Cost per hen day, ...	\$0 0033	\$0 0035
Total weight of eggs (pounds), ...	100.5	83.7
Average weight per egg (ounces), ...	1.98	1.95
Eggs per hen day, ...	.32	.31
Dry matter consumed per hen day (pounds), ...	.22	.23
Dry matter to produce 1 egg (pounds), ...	.695	.739
Nutritive ratio, ...	1:4.6	1:4.7
Sitters, ...	22	13

A test of the eggs both raw and boiled was made by an expert, who found the animal-meal eggs inferior, in color and flavor, to the others.

Conclusion.

In conclusion, then, I may quote the closing summary of results made in my report upon a similar experiment last year. "The advantage in this trial lies, then, clearly with the animal meal as a food for egg-production. It has given more eggs of greater average weight and at considerably less cost than the bone; and it is, moreover, a more convenient food to use, as well as safer." In one respect only is the animal meal apparently inferior to the bone this

year, viz., the fowls getting it weigh less at the close of the experiment than the others. This loss in weight is, however, far more than covered by the greater value of eggs produced.

We have now carried through five experiments, comparing these two feeds. Two have given results slightly favorable to the bone in number of eggs; one a similar result in favor of the animal meal; and two—the two last, which have been the most perfectly carried out—have been most decisively favorable to the animal meal. The latter has also been found the safer food. *The greatly preponderating weight of the evidence afforded by these experiments, which have been most carefully conducted, is, therefore, in favor of the animal meal.*

3. *Narrow v. Wide Ration for Egg-production.*

The experiments coming under this head have been two, one extending from December 12 to April 30, the other from May 1 to October 4. The object in view was to test the correctness of the generally held opinion that the food of the laying hen must be very rich in nitrogenous constituents. As we have carried out the experiment, it amounts to a substitution of corn meal for wheat middlings and gluten feed in the morning mash, and the replacement of about one-half of the oats and the wheat fed at night with the corn. The proportions of cut clover and of animal meal have remained the same in the two rations.

The health of the fowls on both rations has been uniformly good throughout both the winter and summer test, with a single exception,—the loss of one fowl from the effects of indigestion,—on the wide ration. It was found to require the exercise of more judgment in feeding to keep the fowls on the heavier corn ration in perfect condition. They were more easily overfed, and on two or three occasions lost appetite for their feed for short periods.

The Winter Experiment.

On December 12 the pullets, 19 in each lot, weighed as follows: narrow ration, 101.75 pounds; wide ration, 102.5

pounds. The first lot had laid, November 12 to December 12, 127 eggs; the other lot, 85 eggs, and one in this lot was broody. The foods consumed during the winter experiment and other details are shown in the following table:—

Foods consumed, Narrow v. Wide Ration (December 12 to April 30).

KINDS OF FOOD.	Narrow Ration.	Wide Ration.
	lbs. oz.	lbs. oz.
Wheat, ...	257 0	126 0
Oats, ...	147 0	63 0
Bran, ...	43 0	39 0
Middlings, ...	43 0	—
Gluten feed, ...	43 0	—
Animal meal, ...	43 0	39 0
Clover, ...	44 0	39 0
Corn meal, ...	—	108 0
Corn, ...	—	136 0
Cabbage, ...	18 5	16 5

Average Weight of the Fowls (Pounds).

DATES.	Narrow Ration.	Wide Ration.
December 12, ...	5.36	5.39
January 31, ...	5.41	5.84
February 25, ...	5.45	5.80
March 30, ...	5.16	5.57
April 30, ...	5.17	5.31

Number of Eggs per Month, Narrow v. Wide Ration, Winter Test.

MONTHS.	Narrow Ration.	Wide Ration.
December 12 to 31, ...	94	89
January, ...	99	148
February, ...	147	258
March, ...	310	317
April, ...	210	259
Totals, ...	860	1,071

Narrow v. Wide Ration for Egg-production, Winter Test.

	Narrow Ration.	Wide Ration.
Hen days, ...	2,529	2,538
Gross cost of foods, ...	\$8 54	\$6 56
Cost per hen day, ...	\$0 0033	\$0 0026
Total number of eggs, ...	860	1,071
Cost per egg, ...	\$0 0099	\$0 0061
Eggs per hen day, ...	.34—	.42+
Total weight of eggs (pounds), ...	102.425	130.53—
Average weight of eggs (ounces), ...	1.98	1.95
Dry matter to produce one egg (pounds), ...	.655	.46
Dry matter consumed per hen day (pounds), ...	.22	.19
Nutritive ratio, ...	1:4.7—	1:5.6—
Number of sitters, ...	30	24

Summer Experiment.

The summer experiment was continued with the same fowls that had been used in the winter. The method of feeding remained the same, save in two particulars: (1) in place of cut clover rowen in the mash every morning, lawn clippings in such quantity as the fowls would eat before wilting were fed three times per week, to each lot the same; and (2) the feeding of cabbages was discontinued. The yards (fifty by twenty-four feet) were kept fresh by frequent use of the cultivator. The health of one fowl only suffered during the experiment. One of the corn-fed fowls appeared dumpy for a few days, but was fully recovered in two weeks. As in the winter test, the fowls fed largely on corn showed less relish for their whole grain than the others. Food consumed and other details are shown below:—

Foods consumed, Narrow v. Wide Ration (May 1 to October 4).

KINDS OF FOOD.	Narrow Ration.	Wide Ration.
	Lbs.	Lbs.
Wheat, ...	276	131½
Oats, ...	97	43
Bran, ...	43	40
Middlings, ...	43	—
Animal meal, ...	43	40
Corn meal, ...	—	106½
Corn, ...	—	217½
Gluten feed, ...	43	16

Average Weight of the Fowls (Pounds).

DATES.	Narrow Ration.	Wide Ration.
April 30, ...	5.17	5.31
June 11, ...	5.00	5.25
July 16, ...	5.47	5.22
August 11, ...	5.05	5.50
Before killing, ...	5.07	5.44
Dressed, ...	4.37*	4.81†

* Or 86 per cent.

† Or 88 per cent.

Eggs per Month (Number).

MONTHS.	Narrow Ration.	Wide Ration.
May, ...	216	292
June, ...	182	204
July, ...	157	210
August, ...	151	197
September, ...	139	174
October 1-14, ...	14	18
Totals, ...	859	1,095

Narrow v. Wide Ration for Egg-production, Summer Test.

	Narrow Ration.	Wide Ration.
Hen days, ...	2,355	2,512
Gross cost, ...	\$7 56	\$6 64
Cost per hen day, ...	\$0 0032	\$0 0026
Total number of eggs, ...	859	1,095
Cost per egg, ...	\$0 0088	\$0 0061
Eggs per hen day, ...	.36	.44
Total weight of eggs (pounds), ...	106.3	130
Average weight of eggs (ounces), ...	1.98	1.90
Dry matter to produce one egg (pounds), ...	.57+	.48+
Dry matter consumed per hen day (pounds), ...	.21—	.21+
Sitters, ...	67	60

The fowls on the wide (corn) ration laid three soft-shelled eggs during the winter test and one during the summer. These are not included in the tabular reports.

Study of the results reveals the following facts:—

1. *The hens on the wide (rich in corn) ration laid a great many more eggs in both the winter and in the summer experiments than those on the narrower ration.*

2. *The difference in favor of the wide ration amounts to 25 per cent. in the winter trial and to 33½ per cent. in the summer trial, upon the basis of equal number of hen days.*

3. *The total cost of feeds was less for the wide ration, and of course the cost per egg was much less. In the production of one hundred dozen eggs the saving on the basis of our winter test would amount to \$4.56; on the basis of the summer test, to \$3.24.*

4. *In average weight of the eggs produced there is a small difference in favor of the narrow ration; but in quality the weight of family evidence shows the eggs produced by the corn-fed hens to have been somewhat superior. They were deeper yellow and of a milder flavor than the eggs from the narrower ration.*

5. *The fowls on the wide ration gained somewhat in weight and were heavier at the close of the experiment than the others, notwithstanding the much larger number of eggs laid.*

At the close of the experiment the fowls were closely judged as to the condition of the plumage while still living, and it was decided that the corn-fed hens were farther advanced in moulting than the others. The fowls were slaughtered, and the judgment of the men removing the feathers coincided with the judgment on the living fowls.

The averages before and after dressing were as follows: narrow-ration fowls, 5.07 pounds; dressed weight, 4.37 pounds; wide-ration fowls, 5.44 pounds; dressed weight, 4.81 pounds. The narrow-ration fowls gave 86 per cent. dressed weight; the others, 88 per cent. The dressed fowls were judged by a market expert, who pronounced the corn-fed fowls slightly superior to the others.

The results are thus greatly in favor of the ration richer in

corn meal and corn; and so important will a knowledge of this fact prove (if confirmed by further trials), because of the cheapness of these foods as compared with wheat, that the experiment is being repeated this year with three different breeds of fowls, using corn yet more largely than last year.

4. Influence of the Cock on Egg-production.

At the close of the winter tests the hens that had been used in the condition-powder and cut-bone experiments were matched in such a manner as to equalize previous feed conditions in four coops of sixteen fowls each. The fowls were all put upon the same feed, and egg records were kept for two weeks, to determine whether the fowls seemed evenly matched. At the end of the time a vigorous White Leghorn cock was placed in two of the coops. We had thus two experiments co-incidentally running. These will be designated respectively test No. 1 and test No. 2.

Test No. 1. Influence of the Cock on Egg-production. — In the preliminary trial the hens in pen 1 laid 129 eggs; those in pen 2, 107 eggs. In the first pen five hens were brooding; in the second, seven. The fowls in both pens were fed alike, each receiving, in addition to the feed recorded, lawn clippings three times per week. The experiment began May 13 and extended to September 2. In calculating the food cost per hen day the cock is included in the hen days, but in calculating the number of eggs per hen day the cock is not included. No ill health or accidents of any kind occurred. The cock in the trial was in pen 1.

Foods consumed (May 14 to September 2).

KINDS OF FOOD.	Pen 1.	Pen 2.
	Lbs.	Lbs.
Wheat, ...	194	194
Oats, ...	82	78
Bran, ...	32	32
Middlings, ...	32	32
Gluten feed, ...	32	32
Animal meal, ...	32	32

Average Weight of Fowls (Pounds).

DATES.		Pen 1.	Pen 2.
May	14, beginning, ...	5.12	5.09
June	11, ...	4.69	4.91
July	16, ...	4.91	4.94
August	11, ...	4.87	5.09
September	1, end, ...	4.82	4.95

Influence of Cock on Egg-production.

	Cock with Hens.	No Cock with Hens.
Hen days, including cock, ...	1,904	—
Hen days, without cock, ...	1,792	1,792
Gross cost of food, ...	\$5 53	\$5 49
Cost per hen day, ...	\$0 0029	\$0 0031
Total number of eggs, ...	631	630
Cost per egg, ...	\$0 0088	\$0 0087
Eggs per hen day, ...	.35+	.36—
Total weight of eggs (pounds), ...	77.3	76.79
Average weight of eggs (ounces), ...	1.96	1.95
Dry matter consumed per hen day (pounds), ...	.19	.20
Dry matter consumed per egg (pounds), ...	.58—	.57+
Nutritive ratio, ...	1:4.7—	1:4.7
Slitters, ...	41	45

Test No. 2. Influence of the Cock on Egg-production. — During the preliminary period the fowls in pen 5 laid 90 eggs, three offering to sit; those in pen 6 laid 107 eggs, five offering to sit. The cock was placed in pen 6. One hen in pen 6 was lame from July 6 to the end of the test; one in pen 5 was injured in the back on July 22, and died August 4. This test closed August 25.

Foods consumed (May 14 to August 25).

KINDS OF FOOD.	Pen 6.	Pen 5.
	Lbs.	Lbs.
Wheat, ...	179	161½
Oats, ...	80½	81½
Bran, ...	31½	30½
Middlings, ...	31½	30½
Gluten feed, ...	31½	30½
Animal meal, ...	31½	30½

Average Weight of Hens (Pounds).

DATES.	Pen 6.	Pen 5.
May 14, ...	4.91	5.06
June 11, ...	4.79	4.94
July 16, ...	4.91	5.09
August 11, ...	4.94	5.17
August 23, ...	4.72	5.02

Influence of the Cock on Egg-production.

	Cock with Hens.	No Cock with Hens.
Hen days, ...	1,664	1,643
Hen days with cock, ...	1,768	—
Gross cost of foods, ...	\$5 24	\$4 89
Cost per hen day, ...	\$0 0030	\$0 0030
Total number of eggs, ...	629	526
Cost per egg, ...	\$0 0083	\$0 0093
Eggs per hen day, ...	.38+	.33—
Total weight of eggs (pounds), ...	77.84	64.76
Average weight of eggs (ounces), ...	1.98	1.97
Dry matter to produce 1 egg (pounds), ...	.55	.63—
Dry matter consumed per hen day (pounds), ...	.20	.20
Nutritive ratio, ...	1:4.8	1:4.7
Sitters, ...	35	33

Study of these results shows that the cock was without apparent influence upon the egg product of these fowls. The differences are very small, too insignificant to have much weight, even if in both trials of the same nature. When we note, however, that in one trial the balance was very slightly in favor of the set of fowls with which the cock was kept, and that in the other trial it was with the fowls kept without the cock, we must conclude that the results prove neither benefit nor injury due to the presence of the male. In one respect only is there agreement in the results of the two trials; the average weight of the eggs from the hens with which a male was kept was slightly the greater in both trials. It seems not impossible that this effect may be due to the fact that the eggs had been fertilized. The difference is, however, exceedingly small, and would be wholly without significance to the producer of eggs for market or for table use.

REPORT OF THE ENTOMOLOGIST.

CHARLES H. FERNALD.

The work of the past season has been along the lines indicated in a previous report, so far as time and circumstances would permit. It has seemed desirable to give especial attention to the immediate needs of the citizens of this Commonwealth, as indicated by the extensive correspondence, from which one is enabled to gain a pretty clear idea of the insects especially troublesome, and upon which help is needed, from year to year. The work on the gypsy and brown-tail moths has demanded a large amount of time, not only in frequent inspections of the field work in the infested territory, but also in planning and directing the scientific part of the work.

A monograph of the plume-moths (*Pterophoridae*) of North America was prepared and published in the last college report, and a revised edition was issued in July as a special bulletin from this station. Such monographs are absolutely essential as foundation work in economic entomology. I am now at work, when other duties permit, on a similar monograph of the two remaining families of the *Pyrallidae*. Mr. Cooley's monograph on the genus *Chionaspis*, a group of very pernicious scale insects, is now quite far advanced, and will soon be ready for publication.

THE SAN JOSÉ SCALE.

This insect has now unfortunately become established in various parts of the State, and has been sent here for determination during the past season more frequently than any other. This pest, as well as several other injurious scale

insects, has been brought into the State and distributed among our fruit growers on nursery stock; and, unless present in large numbers, they are liable to be entirely overlooked, both by the nurseryman and the purchaser, but when they are discovered, not only does the purchaser suffer from the loss of his trees, but the nurseryman is sure to lose his trade. As a result, some of our more progressive dealers in nursery stock, by my advice, have built fumigating houses, and treat all stock received and sent out, with hydro-cyanic acid gas.

Many of the other States have enacted laws for the regular examination of their nurseries, and also prohibiting the introduction of nursery stock that has not been examined by an expert entomologist, appointed for that purpose by the State from which the stock was shipped, and accompanied by his certificate of examination. This has shut out the trade of our nurserymen more or less from all those States where such laws exist, and, at the same time, leaves Massachusetts as a dumping ground for the infested nursery stock of other States. It is evident, therefore, that we need some law to protect us against the introduction of the San José scale and other injurious insects.

THE GRASS THRIPS.

The amount of damage to grass done by this insect has been estimated at more than that of all others combined. This may be an overestimate, but there is no doubt that it is one of the most destructive grass insects in this Commonwealth. Very little has been known of it, beyond the fact that it is very injurious; but no method of dealing with it has been suggested that promised any great degree of success. One of my assistants has worked out its life history and bred it through all of its stages, and will prepare a bulletin on it soon.

THE SMALL CLOVER-LEAF BEETLE.

This insect (*Phytonomus nigrirostris*) is very common on the college farm, and is quite destructive to the clover on which it feeds. Its habits and life history will be published

when the investigations now being made on it are completed. An allied species, the clover-leaf beetle (*Phytonomus punctatus*), is reported in various parts of this country, and is said to have done a great deal of damage.

THE BUFFALO CARPET BEETLE.

The Buffalo carpet beetle has caused housekeepers more or less trouble for a long time, and the correspondence about this insect has been more extensive during the last ten years than on almost any other. My attention has recently been called to an invasion of this insect in the storehouse of the Geo. Gilbert Manufacturing Company, in Ware, where it was destroying woolen goods. After considering the matter very fully, the owners were advised to close the house as tightly as possible, and fumigate it with hydro-cyanic acid gas. Full instructions were given, in order that no accidents might occur from the use of this deadly gas.

ARSENATE OF LEAD AND BORDEAUX MIXTURE.

Arsenate of lead has proved so valuable an insecticide for the destruction of the gypsy moth, as well as other insects, that several correspondents have inquired if it could be used with Bordeaux mixture. A trial was therefore made on several apple trees on my own grounds, with most excellent results and without any injury to the foliage, though the arsenate of lead was used in the proportion of five pounds to one hundred and fifty gallons of water. The fruit of these trees had been badly affected by the scab for several years, but after a single spraying with the above preparation the fruit in the fall was in excellent condition. Experiments will be performed with these substances another year, before giving a detailed account of the work.

REPORT OF THE CHEMIST.

DEPARTMENT OF FERTILIZERS AND FERTILIZER MATERIALS.

CHARLES A. GOESSMANN.

Assistants: HENRI D. HASKINS, CHARLES I. GOESSMANN, SAMUEL W. WILEY.

Part I. — Report on Official Inspection of Commercial Fertilizers.
Part II. — Report on General Work in the Chemical Laboratory.

PART I. — REPORT ON OFFICIAL INSPECTION OF COMMERCIAL FERTILIZERS AND AGRICULTURAL CHEMICALS IN 1898.

CHARLES A. GOESSMANN.

The number of licensed manufacturers and dealers in commercial fertilizers and agricultural chemicals during the past year is sixty-one. Thirty-five of these parties have offices for the general distribution of their goods in Massachusetts; the remainder reside in other States, — ten in New York, four in Connecticut, three in Vermont, three in Rhode Island, one in Maine, one in New Jersey, one in Illinois and two in Canada.

The distinct brands of fertilizer, including chemicals, licensed in the State, are two hundred and sixty-four.

Three hundred and seventy-eight samples of fertilizers have thus far been collected in the general market by experienced delegates of the station; of these, three hundred and sixty-three samples were analyzed at the close of November, 1898, representing two hundred and sixty-four distinct brands. The results of these analyses were published for distribution in three bulletins, Nos. 51, 54 and 57, of the Hatch Experiment Station of the Massachusetts Agricultural College, during the months of February, July and November, 1898.

The remaining samples and others coming into our hands before the expiration of the license, May 1, 1899, will be analyzed in due time, and the results published in conformity with our State laws for the regulation of the trade in commercial fertilizers.

The modes of chemical analysis adopted in our examination of fertilizers are, in all essential points, those recommended by the Association of Official Chemists.

For a better understanding and due appreciation of the trade in commercial fertilizers during the past year, the following abstract of our results is here inserted. To arrive at a correct conclusion, it must be borne in mind that only the lowest stated guarantee is legally binding on all sales:—

(a) Where three essential elements of plant food were guaranteed:—		1897.	1898.
Number with three elements equal to or above the highest guarantee, ...	3	5	
Number with two elements above the highest guarantee, ...	2	17	
Number with one element above the highest guarantee, ...	60	77	
Number with three elements between the lowest and highest guarantee, ...	69	85	
Number with two elements between the lowest and highest guarantee, ...	63	93	
Number with one element between the lowest and highest guarantee, ...	16	54	
Number with two elements below the lowest guarantee, ...	6	19	
Number with one element below the lowest guarantee, ...	29	90	
(b) Where two essential elements of plant food were guaranteed:—			
Number with two elements above the highest guarantee, ...	3	5	
Number with one element above the highest guarantee, ...	10	24	

	1897.	1898.
Number with two elements between lowest and highest guarantee, ...	13	25
Number with one element between lowest and highest guarantee, ...	12	17
Number with two elements below the lowest guarantee, ...	3	2
Number with one element below the lowest guarantee, ...	6	8

(c) Where one essential element of plant food was guaranteed: —

Number above the highest guarantee, ...	10	18
Number between lowest and highest guarantee, ...	13	23
Number below the lowest guarantee, ...	1	15

A comparison of the above-stated results of our inspection during the years 1897 and 1898 shows no material differences regarding the general character of the fertilizers sold in our market. In a few cases it became our duty to communicate with the manufacturers, and ask for an explanation. Imperfect mixing proved in most of these cases the cause of differences between guarantee and our analysis. As the commercial value of the brand was not materially affected, with only two or three exceptions, the cases were passed over, after a satisfactory explanation from the party interested.

The present condition of the trade in commercial fertilizers offers exceptional advantages to provide efficient manures for the successful raising of farm and garden crops congenial to climate and soil. The fact that the most important essential articles of plant food, as nitrogen, potash and phosphoric acid, are freely offered for sale in our markets in forms suitable to change the manurial refuse of the farm as stable manure and vegetable compost into complete manures for the crops to be raised, deserves the most serious attention of farmers. *To render the stated waste products of the farm in a higher degree efficacious as a manure supply cannot be otherwise considered than as a most promising step in the direction of an economical supply of plant food for the production of farm and garden crops.*

As the manufacturer at best can only prepare his special or so-called complete fertilizers on general lines, not knowing the particular character and condition of the soil which receives them, it becomes the business of the farmer to make

his selection with due care. An intelligent selection of fertilizers from among the various brands offered for sale requires, in the main, two kinds of knowledge; namely, that the brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and proportions as will best meet under existing circumstances the special wants of soil and crop.

As the physical conditions and chemical resources of soils in available plant food frequently differ widely even on the same farm, no definite rule can be given for manuring farm lands, beyond the advice to return to the soil in available form those plant constituents which the crops raised in preceding years have abstracted in exceptionally large proportion, and which will be especially called for by the crops to be raised.

To assist farmers in selecting their fertilizers with reference to the wants of the crops they wish to cultivate, the writer has for years published in his annual reports a compilation of the analyses of farm and garden crops, to serve as a guide to all interested in a rational mode of manuring plants. Copies of these compilations of analyses may be secured by asking for them at the office of the Hatch Experiment Station, at Amherst, Mass.

In making choice from among the so-called complete fertilizers, two points in particular seem to be worth remembering. *First*, select them with reference to the amount, the quality and the kind of essential constituents they are guaranteed to contain, and not merely with reference to the cost per ton; *mere trade names are no guarantee of fitness*. High-priced articles, when offered by reputable manufacturers, have proved in many instances cheaper than low-priced goods. *Second*, buy your supplies of reputable dealers, and insist in all cases on a statement of guaranteed composition.

VALUATION OF COMMERCIAL FERTILIZERS.

The market value of the higher grades of agricultural chemicals and compound fertilizers depends in the majority of cases on the amount and the particular form of

the three essential articles of plant food which they contain, *i.e.*, nitrogen, potash and phosphoric acid. Supply and demand control the temporary market prices not less in the fertilizer trade than in other lines of commercial business.

The approximate value of a fertilizer, simple or compound, is obtained by multiplying the pounds contained in a ton of two thousand pounds by the trade value per pound of each of the three above-stated essential constituents of plant food present. The same course is adopted with reference to the different forms of each, wherever different prices are recognized in the trade. Adding the different values per ton obtained, we find the total value per ton at the principal place of distribution.

As farmers are quite frequently not in the position to secure the desired information regarding the market cost of fertilizers they wish to secure, the official inspectors of commercial fertilizers have aided them for years in ascertaining the current market prices of the following leading or standard raw materials:—

Sulphate of ammonia.	Ammoniate.
Nitrate of soda.	Castor pomace.
Muriate of potash.	Linseed meal.
Sulphate of potash.	Dried blood.
Cotton-seed meal.	Dried ground meat.
Dry ground fish.	Bone and tankage.
Azotin.	Plain superphosphates, etc.

which serve largely in the manufacture of good fertilizers for our market; and have published the results of their inquiries in the form of tables, stating the average trade values per pound, for the six months preceding, of the different kinds and forms of fertilizing materials at the leading places of distribution.

The values stated below are based on the condition of the fertilizer market in centres of distribution in New England during the six months preceding March, 1897 and 1898:—

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1897 and 1898 (Cents per Pound).

	1897.	1898.
Nitrogen in ammonia salts, ...	13.5	14.0
Nitrogen in nitrates, ...	14.0	13.0
Organic nitrogen in dry and fine ground fish, meat blood, and in high-grade mixed fertilizers, ...	14.0	14.0
Organic nitrogen in cotton-seed meal, ...	12.0	12.0
Organic nitrogen in fine bone and tankage, ...	13.5	13.5
Organic nitrogen in medium bone and tankage, ...	11.0	10.0
Phosphoric acid soluble in water, ...	5.5	4.5
Phosphoric acid soluble in ammonium citrate, ...	5.0	4.0
Phosphoric acid in fine bone and tankage, ...	5.0	4.0
Phosphoric acid in cotton-seed meal, castor pomace, wood ashes and fine-ground fish, ...	5.0	4.0
Phosphoric acid in coarse bone and tankage, ...	2.5	3.5
Phosphoric acid insoluble (in ammonium citrate) in mixed fertilizers, ...	2.0	2.0
Potash as sulphate (free from chlorides), ...	5.0	5.0
Potash as muriate, ...	4.5	4.25

From these figures it is apparent that some of the best forms of nitrogen and phosphoric acid have suffered, as a rule, a reduction in cost, as compared with preceding years.

For further details I have to refer to preceding annual reports.

Consumers of commercial manurial substances will do well to buy, whenever practicable, on a guarantee of composition of their essential constituents, and to see that the bill of sale recognizes the point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties.

The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

It is of the first importance, when buying fertilizers for home composition, to consider their cost with reference to what they promise to furnish.

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in the State during the Past Year (May 1, 1898, to May 1, 1899), and the Brands licensed by Each.

The Armour Fertilizer Works, Chicago, Ill. :—

Bone Meal.
Bone and Blood.
Ammoniated Bone and Potash.
All Soluble.
Bone, Blood and Potash.
Grain Grower.

Wm. H. Abbott, Holyoke, Mass. :—
Eagle Brand for Grass and Grain.
Complete Tobacco Fertilizer.

American Cotton Oil Co., New York, N. Y. :—
Cotton-seed Meal.

Butchers' Rendering Association, Fall River, Mass. :—
Bone and Tankage.

Bartlett & Holmes, Springfield, Mass. :—
Pure Ground Bone.
Animal Fertilizer.
Tankage.

H. J. Baker & Bro., New York, N. Y. :—
Standard Un X Ld Fertilizer.
Strawberry Manure.
Potato Manure.
Complete Cabbage Manure.
A. A. Ammoniated Superphosphate.
Complete Manure for General Use.
Grass and Lawn Dressing.

C. A. Bartlett, Worcester, Mass. :—
Fine-ground Bone.
Animal Fertilizer.

Berkshire Mills Co., Bridgeport Conn. :—
Complete Fertilizer.
Ammoniated Bone Phosphate.

Hiram Blanchard, Eastport, Me. :—
Fish, Bone and Potash,  B.

Fish Scrap No. 2,  B.

Bowker Fertilizer Co., Boston, Mass. :—

Stockbridge Special Manures.
Hill and Drill Phosphate.
Farm and Garden Phosphate.
Lawn and Garden Dressing.
Fish and Potash.
Potato and Vegetable Manure.
Potato Phosphate.
Market Garden Manure.
Sure Crop Phosphate.
Gloucester Fish and Potash.
High-grade Fertilizer.
Essex Fertilizer.
Bone and Wood Ash Fertilizer.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.

William E. Brightman, Tiverton, R. I. :—

Potato and Root Manure.
Phosphate.
Fish and Potash.

Bradley Fertilizer Co., Boston, Mass. :—

X. L. Superphosphate.
Potato Manure.
B. D. Sea Fowl Guano.
Complete Mannres.
Fish and Potash.
Ammoniated Bone Phosphate.
Breck's Lawn and Garden Dressing.
Sulphate of Potash.
Corn Phosphate.
Muriate of Potash.
Nitrate of Soda.
Dissolved Bone.
Fine-ground Bone.

Daniel T. Church, Providence, R. I.

(E. Wilcox, general agent) :—

Church's B Special.
Church's C Standard.
Church's D Fish and Potash.

Clark's Cove Fertilizer Co., Boston, Mass. :—

Bay State Fertilizer.
Bay State Fertilizer G. G. Brand.

Clark's Cove Fertilizer Co. — *Con.*

Great Planet Manure.
 Potato Fertilizer.
 King Philip Guano.
 Potato Manure.
 Fish and Potash.
 White Oak Pure Bone Meal.

Cleveland Dryer Co., Boston, Mass. : —

Superphosphate.
 Potato Phosphate.
 Cleveland Fertilizer.

E. Frank Coe Co., New York, N. Y. : —

High-grade Potato Fertilizer.
 Tobacco and Onion Fertilizer.
 High-grade Ammoniated Bone Superphosphate.
 Gold Brand Excelsior Guano.
 Fish Guano and Potash.
 Bay State Phosphate.
 Vegetable and Vine Fertilizer.

Crocker Fertilizer and Chemical Co., Buffalo, N. Y. : —

Ammoniated Bone Superphosphate.
 Potato, Hop and Tobacco Phosphate.
 Ammoniated Wheat and Corn Phosphate.
 New Rival Ammoniated Superphosphate.
 Vegetable Bone Superphosphate.
 General Crop Phosphate.
 Universal Grain Grower.
 Special Potato Manure.
 New England Tobacco and Potato Grower.

Cumberland Bone Phosphate Co., Boston, Mass. : —

Superphosphate.
 Potato Fertilizer.
 Concentrated Phosphate Fertilizer.

L. B. Darling Fertilizer Co., Pawtucket, R. I. : —

Animal Fertilizer.
 Potato and Root Crop Manure.
 Tobacco Grower.
 Blood, Bone and Potash.
 Special Formula.
 Fine-ground Bone.
 Muriate of Potash.
 Nitrate of Soda.
 Farm Favorite.

John C. Dow & Co., Boston, Mass. : —
 Nitrogenous Superphosphate.
 Pure Ground Bone.

Eastern Chemical Co., Boston, Mass. : —

Imperial Liquid Plant Food.

W. E. Fyfe & Co., Clinton, Mass. : —

Wood Ashes.

Great Eastern Fertilizer Co., Rutland, Vt. : —

Northern Corn Special.
 General Fertilizer.
 Vegetable, Vine and Tobacco Fertilizer.
 Garden Special.
 Grass and Oats Fertilizer.

Thomas Hersom & Co., New Bedford, Mass. : —

Bone Meal.
 Meat and Bone.

Edmund Hersey, Hingham, Mass. : —

Ground Bone.

Thomas Kirley, South Hadley Falls, Mass. : —

Pride of the Valley.

Lister's Agricultural Chemical Works, Newark, N. J. : —

Lister's Celebrated Onion Fertilizer.
 Lister's Success Fertilizer.
 Lister's Special Potato Fertilizer.
 Lister's Special Tobacco Fertilizer.

Lowell Fertilizer Co., Boston, Mass. : —

Bone Fertilizer for Corn and Grain.
 Animal Fertilizer.
 Potato Phosphate.
 Bone and Potash.
 Lawn Dressing.
 Tobacco Manure.
 Fruit and Vine Fertilizer.
 Market-garden Fertilizer.
 Ground Bone.

Lowe Bros., & Co., Fitchburg, Mass. : —

Tankage.

F. R. Lalor, Dunville, Ontario, Can. : —

Canada Unleached Hard-wood Ashes.

The Mapes Formula and Peruvian Guano

Co., New York, N. Y.:—

Bone Manures.
 Superphosphates.
 Special Crop Manures.
 Sulphate of Potash.
 Double Manure Salts.
 Nitrate of Soda.

E. McGarvey & Co., London, Ontario,
 Can.:—

Unleached Hard-wood Ashes.

McQuade Bros., West Auburn, Mass.:—
 Pine-ground Bone.

Geo. L. Monroe, Oswego, N. Y.:—
 Canada Unleached Hard-wood
 Ashes.

National Fertilizer Co., Bridgeport,
 Conn.:—

Complete Fertilizers.
 Ammoniated Bone.
 Market-garden Manure.
 Potato Phosphate.
 Fish and Potash.
 Ground Bone.

Niagara Fertilizer Works, Buffalo,
 N. Y.:—
 Wheat and Corn Producer.
 Potato, Tobacco and Hop Fertilizer.
 Niagara Triumph.

Packers Union Fertilizer Co., New
 York, N. Y.:—

Universal Fertilizer.
 Wheat, Oats and Clover Fertilizer.
 Animal Corn Fertilizer.
 Potato Manure:
 Gardener's Complete Manure.

Pacific Guano Co., Boston, Mass.:—

Soluble Pacific Guano.
 Special Potato Manure.
 Nobsque Guano.
 High-grade General Fertilizer.
 Grass and Grain Fertilizer.
 Fish and Potash.
 Pacific Guano with 10 per cent.
 Potash.

Parmenter & Polsey Fertilizer Co.,
 Peabody, Mass.:—

Plymouth Rock Brand.
 Star Brand Superphosphate.

Parmenter & Polsey Fertilizer Co.—
 Con.

Special Potato.
 Strawberry and Small Fruits.
 Ground Bone.
 Muriate of Potash.
 Sulphate of Potash.
 Nitrate of Soda.
 P. & P. Potato Fertilizer.

A. W. Perkins & Co., Rutland, Vt.:—
 Plantene.

Prentiss, Brooks & Co., Holyoke,
 Mass.:—

Complete Manures.
 Phosphate.
 Nitrate of Soda.
 Muriate of Potash.
 Sulphate of Potash.

Preston Fertilizer Co., Brooklyn,
 N. Y.:—

Pioneer.
 Potato Fertilizer.
 Superphosphate, I.

Quinnipiac Co., Boston, Mass.:—

Phosphate.
 Potato Manure.
 Market-garden Manure.
 Fish and Potash.
 Grass Fertilizer.
 Corn Manure.
 Potato Phosphate.
 Climax Phosphate.
 Pure Ground Bone.
 Muriate of Potash.
 Sulphate of Potash.
 Nitrate of Soda.
 Kainit.
 Dissolved Bone-black.

Benjamin Randall, East Boston,
 Mass.:—

Market-garden Fertilizer.
 Farm and Field.
 Ground Raw Bone.

Read Fertilizer Co., New York, N. Y.

(H. D. Foster, general agent):—

Standard Fertilizer.
 High-grade Farmers' Friend.
 Practical Potato Special.
 Vegetable and Vine.
 Fish, Bone and Potash.

N. Roy & Son, South Attleborough,
Mass. :—
Complete Animal Fertilizer.

The Rogers & Hubbard Co., Middle-
town, Conn. :—

Hubbard's Soluble Potato Manure.
Hubbard's Soluble Tobacco Manure.
Hubbard's Fairchild's Formula for
Corn and General Crops.

Hubbard's Grass and Grain Fertilizer.

Hubbard's Oats and Top-dressing
Fertilizer.

Hubbard's Pure Raw Knuckle Bone
Flour.

Hubbard's Strictly Pure Fine Bone.
Hubbard's Fertilizer for all Soils
and all Crops.

Russia Cement Co., Gloucester, Mass. :—

X X X Fish and Potash.

High-grade Superphosphate.

Corn, Grain and Grass Manure.

Potato, Root and Vegetable Manure.

Odorless Lawn Dressing.

Potato Fertilizer.

Dry Ground Fish.

Special Manure for Carnations.

Lucien Sanderson, New Haven, Conn. :—

Formula A.

Blood, Bone and Meat.

Dissolved Bone-black.

Nitrate of Soda.

Sulphate of Potash.

Muriate of Potash.

Sanderson's Old Reliable Super-
phosphate.

Sanderson's Potato Manure.

Edward H. Smith, Northborough,
Mass. :—

Ground Bone.

Thomas L. Stetson, Randolph, Mass. :—

Ground Bone.

Standard Fertilizer Co., Boston, Mass. :—

Standard Fertilizer.

Standard Guano.

Complete Manure.

Special for Potatoes.

C. F. Sturtevant, Hartford, Conn. :—

Tobacco and Sulphur Fertilizer.

Henry F. Tucker, Boston, Mass. :—

Original Bay State Bone Super-
phosphate.

Imperial Bone Superphosphate.

Special Potato Fertilizer.

Bay State Special.

Andrew H. Ward, Boston, Mass. :—

Ward's Chemical Fertilizer.

I. S. Whittemore, Wayland, Mass. :—

Complete Manure.

D. Whithead, Lowell, Mass. :—

Champion Garden Fertilizer.

Bone Meal.

The Wilcox Fertilizer Works, Mystic,
Conn. :—

Potato, Onion and Tobacco Manure.

High-grade fish and potash.

Dry Ground Fish Guano.

Fish and Potash 1895 Brand.

Williams and Clark Fertilizer Co., Bos-
ton, Mass. :—

Ammoniated Bone Superphosphate.

Potato Phosphate.

High-grade Special.

Fine Wrapper Tobacco Grower.

Royal Bone Phosphate.

Corn Phosphate.

Potato Manure.

Grass Manure.

Fish and Potash.

Prolific Crop Producer.

Onion Manure.

Bone Meal.

Dry Ground Fish.

Sulphate of Potash.

Muriate of Potash.

Nitrate of Soda.

Dissolved Bone-black.

M. E. Wheeler & Co., Rutland, Vt. :—

High-grade Corn Fertilizer.

High-grade Potato Manure.

Superior Truck Fertilizer.

High-grade Fruit Fertilizer.

High-grade Grass and Oats Fertilizer.

A. L. Warren, Northborough, Mass. :—

Fine-ground Bone.

Sanford Winter, Brockton, Mass. :—

Fine-ground Bone.

PART II. — REPORT ON GENERAL WORK IN THE CHEMICAL LABORATORY.

CHARLES A. GOESSMANN.

1. Analyses of Materials sent on for Examination.
2. Notes on Wood Ashes, Condition of Trade, etc.
3. Notes on Fertilizers for Pot Cultivation and Green-houses.
4. Observations regarding the Action of Acid and Basic Phosphates on the Availability of the Nitrogen in Blood, Steamed Leather and Leather Scraps.
5. Notes on the Determination of the Available Phosphoric Acid in the Soil.
6. Analyses of Drainage Waters obtained in Connection with Some Field Experiments carried on upon the Grounds of the Station.

1. ANALYSES OF MATERIALS SENT ON FOR EXAMINATION.

The number of substances tested in this connection amount to several hundred. The results of our examination are already published in detail in Bulletins 51, 54 and 57 of the Hatch Experiment Station of the Massachusetts Agricultural College, in connection with the results of the official inspection of commercial fertilizers collected from original packages by an efficient delegate of the station.

The responsibility of the genuineness of the articles sent on for examination rests in all cases with the parties asking for the analysis. Our publication of the results refers merely to the locality they come from, to avoid misunderstandings. The work carried on in this connection is growing from year to year in importance.

A large proportion of commercial manurial substances consist of by or waste products of various industries. The composition and general character of these materials depend

on the current mode of manufacture. The rapid advancement in many branches of industries is at any time liable to affect more or less seriously the commercial as well as the manurial value of their waste products. A frequent examination of that class of materials cannot fail to benefit the vital interests of our farming community. For this reason, arrangements were made, as in previous years, to attend to the examination of substances of interest to farmers, to the full extent of the resources placed at the disposal of the officer in charge of this work.

These investigations are carried on free of charge to farmers of the State, and as far as the financial resources of the laboratory admit. The examination of the materials is, as a rule, carried on in the order they arrive at the station, and the results are considered public property.

The following statement of the names of the different articles sent on and thus far analyzed may suffice here to convey some more definite idea concerning the general character of the work:—

Materials sent on, Dec. 1, 1897, to Dec. 1, 1898.

Air-dried potatoes, ...	9	Peat, ...	1
Acid phosphate, ...	2	Nitrate of soda, ...	3
Ashes from cremation of garbage, ...	1	Sulphate of ammonia, ...	1
Bleachery refuse, ...	2	Sulphate of potash and magnesia, ...	1
Broom corn seed, ...	1	Sulphate of potash, ...	2
Cotton-seed meal, ...	2	Sweet clover hay, ...	3
Compound fertilizers, ...	21	Sulphate of magnesia, ...	1
Cremation ashes, ...	1	Soya bean refuse, ...	1
Dissolved bone-black, ...	1	Starch, ...	2
Fodder material, ...	1	Sewage, ...	1
Ground bone, ...	9	Soil, ...	12
Ground fish, ...	1	Silicate of potash, ...	1
Hop refuse, ...	1	Tankage, ...	3
Lime-kiln ashes, ...	2	Tobacco stems, ...	1
Liquid fertilizer, ...	1	Tobacco refuse, ...	1
Manure, ...	12	Teopik fibre, ...	1
Marl, ...	1	Wood ashes, ...	79
Muriate of potash, ...	3	Wool waste, ...	1
Muck, ...	5	Whale-bone scrapings, ...	1
Minerals, ...	3	Vat deposit, ...	1
Oxalic acid, ...	1		

A few of the more important of the above-stated materials, as wood ashes, etc., are discussed more at length in subsequent pages.

2. NOTES ON WOOD ASHES.

Wood ashes for manurial purposes are in our State subject to official inspection, and dealers in that commodity have to secure a license to sell in our State before they can legally advertise their articles for sale. This circumstance makes it obligatory on the dealers to state the amount of potash and of phosphoric acid they guarantee in these materials, and to fasten that statement upon the package or car, etc., which contains them.

Some dealers in wood ashes have adopted of late the practice of stating merely the sum of both, instead of specifying the amount of each of them present. As phosphoric acid and potassium oxide contained in wood ashes are considered, in our section of the country, pound for pound of an equal commercial value, from 4.5 to 5 cents, no particular objection can be raised against a joint statement of both, as far as the mere money value of the samples is concerned; yet, as this mode of stating the guaranteed composition is apt to lead to misconception and abuse, it ought to be discouraged and discontinued.

As the dealer is only obliged to guarantee the amount of potash and of phosphoric acid present in a given quantity of wood ashes, no serious objection can be raised on the part of the buyer on account of moisture, etc., as long as the article contains the specified amount of both potash and phosphoric acid. Wood ashes ought to be bought and sold by weight, and not by measure, for both moisture and the general character of foreign matters are apt to seriously affect the weight of a given measure.

During the past year (1898) 40.1 per cent. of the materials sent on for analysis consisted of wood-ash samples; during the preceding year (1897) they amounted to 40 per cent.

The general character of the wood ashes sold during the stated years may be judged from the following classified statement of our results:—

						No. of Samples.	
						1897.	1898.
Moisture from 1 to 3 per cent.,	.	.	.	.	.	10	9
Moisture from 3 to 6 per cent.,	.	.	.	.	.	8	6
Moisture from 6 to 10 per cent.,	.	.	.	.	.	13	20
Moisture from 10 to 15 per cent.,	.	.	.	.	.	19	22
Moisture from 15 to 20 per cent.,	.	.	.	.	.	11	16
Moisture from 20 to 30 per cent.,	.	.	.	.	.	10	6
Moisture above 35 per cent.,	.	.	.	.	.	1	—
Potassium oxide above 8 per cent.,	.	.	.	.	.	3	4
Potassium oxide from 7 to 8 per cent.,	.	.	.	.	.	8	6
Potassium oxide from 6 to 7 per cent.,	.	.	.	.	.	21	8
Potassium oxide from 5 to 6 per cent.,	.	.	.	.	.	28	22
Potassium oxide from 4 to 5 per cent.,	.	.	.	.	.	10	25
Potassium oxide from 3 to 4 per cent.,	.	.	.	.	.	3	11
Potassium oxide below 3 per cent.,	.	.	.	.	.	—	3
Phosphoric acid above 2 per cent.,	.	.	.	.	.	4	6
Phosphoric acid from 1 to 2 per cent.,	.	.	.	.	.	45	60
Phosphoric acid below 1 per cent.,	.	.	.	.	.	24	13
Average per cent. of calcium oxide (lime),	.	.	.	.	.	34.29	33.60
Per cent. mineral matter insoluble in diluted hydrochloric acid, from —	{ below 5, ...					—	1
	{ 6 to 10, ...					10	16
	{ 10 to 15, ...					30	31
	{ 15 to 20, ...					15	15
	{ 20 to 30, ...					3	13
	{ above 30, ...					1	—

As the majority of dealers in wood ashes guarantee from 4.5 to 6 per cent. of potassium oxide in their articles, it will be seen that a large number of the samples are below even the lowest guarantee; showing, on the whole, that the quality of wood ashes sold in 1898 as a potash source has been inferior, when compared with the preceding year. Whether this circumstance is due to a general decline of the article or to the management of any particular importer or dealer is difficult to decide on our part, as long as farmers do not state the name of the party from whom they have bought, or the cost per ton of the ashes they send on for examination.

It is most desirable to ascertain whether the general character of the wood ashes is gradually declining from natural causes, or whether some parties are handling inferior goods. All interested in the solution of this question will confer a favor on us by sending with their samples of wood ashes the names of the party from whom they bought the article, and

state the price per ton asked at the nearest depot for general distribution.

The large percentage of lime, from 30 to 40 per cent., found in genuine wood ashes, imparts a special agricultural value to them as a fertilizer, aside from the amount of potash and phosphoric acid they contain. Wherever an application of lime is desired, wood ashes deserve favorable consideration, on account of the superior mechanical condition of the lime they furnish.

3. NOTES ON FERTILIZERS SUITABLE FOR RAISING PLANTS IN POTS AND GREENHOUSES.

The interest in raising plants in pots and under glass in greenhouses, by the aid of commercial fertilizers, is gradually increasing, judging from numerous applications for information.

The following analyses represent two samples of fertilizers recommended for that purpose; they were sent on for a general analysis by parties interested in the matter:—

1. *Plant Food in Pellet Form, sent on from Newtonville, Mass.*

	Per Cent.
Moisture, ...	3.39
Organic and volatile matter, ...	41.15
Ash constituents, ...	58.85
Water soluble material, ...	82.40
Insoluble residue (in water), ...	17.60
Total phosphoric acid, ...	16.59
Soluble phosphoric acid, ...	14.58
Reverted phosphoric acid, ...	1.67
Insoluble phosphoric acid, ...	.34
Potassium oxide, total, ...	7.96
Potassium oxide, water soluble, ...	7.63
Sodium oxide, ...	6.19
Calcium oxide, ...	4.04
Magnesium oxide, ...	5.30
Chlorine, ...	6.05
Sulphuric acid (SO_3), ...	17.17
Total nitrogen, ...	7.65
Nitrogen as ammoniates, ...	7.06
Nitrogen as nitrates, ...	.50
Nitrogen as organic matter, ...	.09
Insoluble matter in dilute hydrochloric acid (clay), ...	14.33
Water solution strongly acid.	

2. *Liquid Fertilizer sent on from Natick, Mass.*

	Per Cent.
Moisture, ...	90.46
Solid residue, ...	9.54
Phosphoric acid, ...	1.24
Potassium oxide, ...	2.79
Sodium oxide, ...	1.67
Calcium oxide, ...	1.82
Magnesium oxide, ...	.07
Chlorine, ...	.02
Sulphuric acid (SO ₃), ...	—
Total nitrogen, ...	1.12
Nitrogen as ammoniates, ...	.39
Nitrogen as nitrates, ...	.73
Reaction strongly acid.	

The importance of the interests involved induced the writer some years ago to enter upon a series of experiments, to assist in the development of a more efficient system of manuring several important industrial crops, fruits and garden vegetables. The first results of that investigation are published in the eleventh and twelfth reports of the director of the Massachusetts State Agricultural Experiment Station, to which I have to refer for details. Those of later years are contained in the annual report of the Hatch Experiment Station of the Massachusetts Agricultural College for 1896 and 1897.

In the course of my discussion of the lessons to be derived from the above-stated experiment in field and vegetation house, it was recommended to observe the following rules:—

1. To avoid an accumulation of half-decayed vegetable matter in the soil, and to enrich the latter in the desired direction by means of concentrated chemical manures.

2. To change, wherever practicable, from season to season the position of the various crops, to favor the destruction of parasites and to economize the inherent sources of plant food.

3. To avoid an accumulation of salines in the soil, not called for by the crops, or considered injurious to the chemical or physical properties of the soil.

4. To prevent a marked acidity of the soil, by a periodical application of air-slacked lime, wood ashes, etc.

5. To select the various commercial forms of nitrogen, and potash in particular, with special reference to the kind and the desired character of the crop to be raised.

6. To use as a general fertilizer a mixture of two parts of available potassium oxide, one part of available nitrogen and one part of available phosphoric acid, in such quantities per acre as the conditions of the soil and composition of the crop to be raised called for; allowing, for the composition of one thousand pounds of green garden vegetables, on an average:—

	Pounds.
Nitrogen, ...	4.01
Phosphoric acid, ...	1.90
Potassium oxide, ...	3.90

On account of the frequent cultivation of beans and peas as garden crops, a fertilizer of the following composition suggested itself to me:—

	Parts.
Available nitrogen, ...	1
Available potash, ...	2
Available phosphoric acid, ...	1

More recent observations confirm the advisability of the previously stated rules in a general way; yet they also emphasize the fact that, wherever the quality of the crop controls its economical and commercial value, it seems advisable that care should be taken to secure the exclusion of an accumulation of soluble saline substances not called for by the crop. This circumstance deserves particular attention in cultivation under glass, where the body of the soil is limited, and the removal of such substances by percolation to the lower layers offers but little chance of relief.

In our experiments above described this view of the question of supplying plant food in the greenhouse has aided us in selecting a series of concentrated chemical manures, which for the above reason are now recommended for patronage:—

NAME OF SUBSTANCE.	Potassium Oxide (Per Cent.).	Phosphoric Acid (Per Cent.).	Nitrogen (Per Cent.).
High-grade muriate of potash, ...	50.00	-	-
High-grade sulphate of potash, ...	50.20	-	-
Potash-magnesia sulphate, ...	24.32	-	-
Carbonate of potash-magnesia, ...	18.48	-	-
Phosphate of potash, ...	32.56	35.70	-
Dissolved bone-black, ...	-	13.88	-
Odorless phosphate, phosphatic slag, . .	-	18.42	-
Double superphosphate, ...	-	47.80	-
Phosphate of ammonia, ...	-	43.86	10.37
Dried blood, ...	-	4.02	10.00
Nitrate of soda, ...	-	-	14.28
Sulphate of ammonia, ...	-	-	19.59

As the local conditions of the soil and the composition of the individual characteristics of the plants to be raised deserve especial attention, when selecting from the above-stated commercial manurial substances the constituents for the fertilizer mixtures to be used, it cannot be considered judicious to recommend any particular combination as being unfailing and best in all cases. For this reason it has been thought best to state in this connection, as a mere matter of illustration, a few combinations of manurial substances which served us well, as may be noticed from a few preceding annual reports, — State Experiment Station, 1893, pages 241 to 261; and 1894, pages 274 to 285.

The amount of fertilizer recommended per acre, under fair conditions of the soil, contains: —

	Pounds.
Available nitrogen, ...	60
Available phosphoric acid, ...	60
Available potash, ...	120

Some Combinations of High-grade Substances for Use in Garden, Greenhouse and Pots.

- | | |
|--|--|
| 1. Nitrate of soda.
High-grade sulphate of potash.
Dissolved bone-black. | 3. Dried blood.
High-grade sulphate of potash.
Dissolved bone-black. |
| 2. Sulphate of ammonia.
High-grade sulphate of potash.
Dissolved bone-black. | 4. Nitrate of soda.
Muriate of potash.
Dissolved bone-black. |

Mixtures of muriate of potash and sulphate of ammonia have proved in our experience in many cases objectionable, on account of a mutual decomposition into chloride of ammonia and sulphate of potash.

4. OBSERVATIONS WITH DRIED BLOOD AND TWO KINDS OF LEATHER REFUSE AS THE SOURCES OF NITROGEN FOR GROWING RYE IN PRESENCE OF ACID AND OF ALKALINE PHOSPHATES.

In a preceding report an experiment has been briefly described in which dried blood has been compared with leather refuse as a nitrogen source for growing plants, when used in connection with double phosphate and muriate of potash. The differences of the crops raised were more marked with reference to the yield of the straw than to that of the grain. (For details, see annual report of the Massachusetts State Agricultural Experiment Station for 1894, pages 283–285.) It seemed advisable to repeat the experiments, with such modifications as experience suggested, to secure, if possible, *more decisive results*, and to ascertain whether the degree of availability of the nitrogen contained in the dried blood and in the leather refuse would not be more strikingly modified by using *alkaline phosphates* instead of *acid phosphates* as the phosphoric acid source.

The following course was adopted. Winter rye was again selected for the observation. The soil used was taken from the same locality, at eighteen inches below the surface, and freed from coarse materials by repeated screening through a sand screen, as in the first experiment. The fertilizers used were in each case carefully distributed throughout the entire body of the soil. The boxes were the same which had been used in the preceding experiments, containing from seventy-five to eighty pounds of soil, having a depth of eighteen inches.

Six boxes were employed in the experiment; three served for the trial with acid phosphate, — dissolved bone-black; and three with an alkaline phosphate, — phosphatic slag meal. The following mixtures of fertilizers were used (weights are stated in grams; thirty grams equal to one ounce) : —

First Lot, Nos. 1, 3 and 5.

<i>Box 1.</i>			<i>Box 3.</i>	
Sulphate of potash, . .	7.68		Sulphate of potash, . .	7.68
Dissolved bone-black, . .	24.38		Dissolved bone-black, . .	24.38
Dried blood, ...	40.22		Philadelphia tankage (a steamed leather refuse), .	57.16

Box 5.

Sulphate of potash, ...	7.68
Dissolved bone-black, ...	24.38
Raw-leather waste, ...	56.64

Second Lot, Nos. 2, 4 and 6.

<i>Box 2.</i>			<i>Box 4.</i>	
Sulphate of potash, ...	7.68		Sulphate of potash, ...	7.68
Phosphatic slag meal, . . .	24.38		Phosphatic slag meal, . . .	24.38
Dried blood, ...	40.22		Philadelphia tankage (a steamed leather refuse), .	57.16

Box 6.

Sulphate of potash, ...	7.68
Phosphatic slag meal, ...	24.38
Raw-leather waste, ...	56.64

The Seed. — Winter rye was planted in all boxes Oct. 2, 1894. The young plants came up uniformly in all boxes October 5. They reached a height of from five to six inches before frost set in. After being fully developed, they were reduced in all the boxes to a corresponding number, as in the first experiment.

The watering of the soil was partly by subirrigation and partly by surface application, maintaining as far as practicable the moisture of the soil from 15 to 18 per cent. during the growing season. The experiment was conducted with a view to expose the soil to the unrestricted influence of the local temperature of the various seasons. A layer of snow served as protection to the young growth during severe spells of frost in winter.

The manurial substances used consisted of high-grade sulphate of potash, dissolved bone-black, phosphatic slag meal, dried blood, Philadelphia tankage (a steamed leather), and ground sole leather waste. The amount of nitrogen and

potassium oxide applied was the same in each case, while the amount of total phosphoric acid applied in case of the phosphatic slag meal was one-fourth more than in the case of the dissolved bone-black, which is practically all soluble in water.

Composition of the Manurial Substance used, with Reference to Potash, Phosphoric Acid and Nitrogen (Per Cent.).

	Potassium Oxide.	Phosphoric Acid.	Nitrogen.
Sulphate of potash, ...	50.20	-	-
Dissolved bone-black, ...	-	14.00	-
Phosphatic slag meal,*	-	13.40	-
Dried blood, ...	-	4.00	10.00
Philadelphia tankage (steamed leather), . .	-	-	7.80
Ground leather waste, ...	-	-	7.02

* Calcium oxide, 48.6 per cent.

They grew at a similar rate during spring until the latter part of April, when those which had received dried blood as nitrogen source (boxes 1 and 2) became more stalky, developing more and broader leaves than the plants in boxes 3, 4, 5 and 6. This difference in their growth became more marked as the season advanced.

The following statement gives the average height of the plants at various stages of observation (inches) : —

	May 1.	May 9.	May 20.	June 1.
Box 1, ...	8.0	21.5	34.0	50.0
Box 3, ...	7.0	16.5	24.0	32.0
Box 5, ...	6.0	14.0	22.5	30.5
Box 2, ...	9.0	26.0	38.0	56.5
Box 4, ...	7.0	17.5	25.0	32.5
Box 6, ...	7.0	17.5	26.0	35.0

The plants in all boxes began blooming about the same time, the first week of June; they were harvested the first week of July. There was no marked difference in regard

to time of maturing. The general character of the matured growth will be seen from the subsequent statement of the weights of the average plant in each case (grams) : —

	Box 1.	Box 3.	Box 5.	Box 2.	Box 4.	Box 6.
Moisture, ...	8.9	8.9	8.9	8.9	8.9	8.9
Total plant, ...	57.87	26.02	28.80	115.99	30.27	36.21
Kernels, ...	12.77	5.43	5.80	28.89	6.18	9.75
Chaff and straw, ...	45.12	20.69	23.00	87.10	24.09	26.46
One hundred kernels, ...	1.58	1.44	1.48	1.79	1.58	1.62

The plants were in all cases cut two inches above their roots. As it was of interest to know the amount of nitrogen in the kernels of the highest and lowest weights, a nitrogen determination of the kernels obtained in boxes 1 and 3, and 2 and 4 was carried out. The analyses gave the following results : —

No. of Box.	Per Cent. Nitrogen.	Fertilizing Elements Used.
1, ...	1.84	Dried blood, dissolved bone-black.
3, ...	1.91	Philadelphia tankage, dissolved bone-black.
2, ...	2.31	Dried blood, phosphatic slag.
4, ...	2.19	Philadelphia tankage, phosphatic slag.

Fodder Analyses of Rye Samples (Kernels) as far as Material on Hand sufficed for a Complete Analysis. Samples grown in Boxes 1, 2, 3 and 4 (Per Cent.).

	Box 1.	Box 2.	Box 3.	Box 4.
Moisture, ...	10.45	9.92	4.87	8.50
Dry matter, ...	89.55	90.08	95.13	91.50
	100.00	100.00	100.00	100.00

Analysis of Dry Matter.

	Box 1.	Box 2.	Box 3.	Box 4.
Fat, ...	2.05	2.00	2.12	1.97
Protein, ...	11.50	14.44	11.94	13.69
Cellulose, ...	1.55	1.65	1.65	1.62
Ashes, ...	1.95	1.52	2.20	1.44
Carbohydrates, ...	82.95	80.39	82.09	81.28
	100.00	100.00	100.00	100.00

Judging from the results obtained in connection with the described experiment the following conclusions suggest themselves : —

Conclusions. — The alkaline phosphate (phosphatic slag meal) has under fairly corresponding conditions increased the availability of the nitrogen contained in steamed leather, in leather scraps and in dried blood in a higher degree than the acid phosphate. The influence is apparent alike in the general character of the entire plant and in the composition of the kernels. The difference in the relative agricultural value of both articles as nitrogen sources remains, however, the same; for leather in any form, without a previous destruction of the tanning principle, tannin, is worthless for manurial purposes.

5. CONTRIBUTION TO THE DETERMINATION OF THE AVAILABLE PHOSPHORIC ACID IN SOILS UNDER CULTIVATION.

The fact that agricultural chemists have thus far failed to point out any mode of soil analysis as reliable, by which the amount of phosphoric acid available to crops can be ascertained, is pretty generally recognized. Attempts are not wanting to solve this important question. Among the well-known investigations in that direction are those of Dr. B. Deyer (1894). Results of later years obtained in this connection upon soils of well-known history at Rothamsted in England are pronounced very encouraging by Dr. Gilbert. The American Association of Official Chemists has during the past year entered upon a systematic investigation

regarding the best course to be adopted to determine the available phosphoric acid; in this work the writer has taken some part. A compilation of the contributions to these more recent experiments is to be published soon by the United States Department of Agriculture.

Our local observations at Amherst are briefly described in a few subsequent pages upon a field which had been under careful observation for five years, 1890-95. The following brief abstract of the management of the field work shows the condition of the soil which served for our investigation:—

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article,

namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture, ...	.47	12.52	2.53	.39	15.96
Ash, ...	-	75.99	89.52	-	61.46
Calcium oxide, ...	46.47	37.49	17.89	46.76	-
Magnesium oxide, ...	5.05	-	-	-	-
Ferric and aluminic oxides, ...	14.35	-	14.25	5.78	-
Total phosphoric acid, ...	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid, ...	-	-	-	-	12.65
Reverted phosphoric acid, ...	-	7.55	-	4.27	2.52
Insoluble phosphoric acid, ...	-	14.33	-	23.30	.65
Insoluble matter, ...	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever:—

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet), ...	Ground phosphatic slag, ...	127
	Nitrate of soda, ...	43
	Potash-magnesia sulphate, ...	58
Plat 2 (6,565 square feet), ...	Ground Mona guano, ...	128
	Nitrate of soda, ...	43½
	Potash-magnesia sulphate, ...	59
Plat 3 (6,636 square feet), ...	Ground Florida phosphate, ...	129
	Nitrate of soda, ...	44
	Potash-magnesia sulphate, ...	59
Plat 4 (6,707 square feet), ...	South Carolina phosphate, ...	131
	Nitrate of soda, ...	44½
	Potash-magnesia sulphate, ...	60
Plat 5 (6,778 square feet), ...	Dissolved bone-black, ...	78
	Nitrate of soda, ...	45
	Potash-magnesia sulphate, ...	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Potatoes were raised upon the plats in 1890; in 1891 winter wheat was employed (for details see ninth annual report); in 1892 serradella was the crop experimented with (see tenth annual report); and in 1893 a variety of Dent corn, Pride of the North (see eleventh annual report).

1894. — During the preceding season it was decided to ascertain the after-effect of the phosphoric acid applied during previous years by excluding it from the fertilizer applied. In addition, to secure the full effect of the phosphoric acid stored up, the potassium oxide and nitrogen were increased one-half, as compared with preceding seasons. A grain crop (barley) calling for a liberal amount of phosphoric acid was chosen for the trial. The field was ploughed April 17, the fertilizer being applied broadcast April 20, and harrowed in. Below is given a statement of fertilizer applied: —

Plat 1 (6,494 square feet), ...	{ 64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet), ...	{ 65½ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet), ...	{ 66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet), ...	{ 66½ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet), ...	{ 67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

Yield of Crop (1894).

PLATS.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Summary of Yield of Crop (1890-94).

PLATS.		1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.
Plat 1,	.	1,600	380	4,070	1,660	490
Plat 2,	.	1,415	340	3,410	1,381	405
Plat 3,	.	1,500	215	2,750	1,347	290
Plat 4,	.	1,830	380	3,110	1,469	460
Plat 5,	.	2,120	405	2,920	1,322	390

Phosphoric Acid applied to and removed from Field.

[Pounds.]

PLATS.	1890.		1891.		1892.		1893.		1894.		Total Amount Added.	Total Amount Removed.	Total Amount Remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1,	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	-*	1.92	96.72	21.86	75.86
Plat 2,	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	-*	1.64	72.04	19.02	53.02
Plat 3,	109.68	2.40	-*	.69	28.01	6.05	28.01	5.95	-*	.76	165.70	15.85	149.85
Plat 4,	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	-*	1.72	144.48	19.84	124.64
Plat 5,	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	-*	1.49	49.36	18.57	30.79

* None.

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the first two years, while for the third, fourth and fifth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

DESCRIPTION OF MODES OF ANALYSIS ADOPTED IN OUR INVESTIGATIONS OF SAMPLES OF SOIL TAKEN FROM THE ABOVE-MENTIONED FIVE PLATS IN SEPTEMBER, 1894, IN THE MANNER RECOMMENDED BY THE COMMITTEE OF THE AMERICAN ASSOCIATION OF OFFICIAL CHEMISTS, PROF. HARRY SNYDER OF MINNESOTA, CHAIRMAN.

I. — Total Phosphoric Acid.

Ten grams of soil are digested with 100 c.c. of pure hydrochloric acid, of specific gravity 1.115, for ten con-

secutive hours in a boiling-water bath, shaking once each hour. The stopper of the flask should carry a condensing tube, to prevent evaporation. The material is filtered, and the residue is washed with distilled water until free of acid. The organic matter in filtrate is oxidized with nitric acid and evaporated to dryness on the water bath, finishing on sand bath to complete dryness. The material when cool is taken up with hot water and a few cubic centimeters of hydrochloric acid, and again evaporated to complete dryness. It is taken up as before, filtered and washed thoroughly with cold water, cooled and made up to 500 c.c.

II. — Directions of the Association of Official Agricultural Chemists for the Determination of Available Phosphoric Acid in Soils, Fifth Normal Hydrochloric Acid being used as the Solvent.

1. *Determination of Moisture.* — Use the official method described in Bulletin 46, page 48, Division of Chemistry, United States Department of Agriculture. Calculate all results to the water free basis.

2. *Determination of Phosphoric Acid Soluble in Fifth Normal Hydrochloric Acid.* — (a) Preliminary treatment: Digest 20 grams of soil with 200 c.c. of fifth normal hydrochloric acid at 40° C. for five hours. Titrate 20 c.c. of the clear filtrate against a standard caustic soda solution, using phenolphthaline for the indicator. From this data calculate the amount of hydrochloric acid necessary to be added, so that the solution will be fifth normal after allowing for the acid neutralized. (b) The determination: Weigh out 50 to 100 grams of soil into an Erlenmeyer flask, and add 10 c.c. of acid, corrected for neutralization as directed under (a) for every gram of soil used. The flask is corked with a rubber stopper, which carries a thermometer. The flask is then placed in a water bath previously heated to 40° C., and the contents of the flask are thoroughly shaken every half hour during the digestion. The solution is then filtered through a ribbed filter of two thicknesses of paper, refiltering the first portion, if cloudy. The filter should be large enough to receive the entire contents of the flask. Before filtering the contents, the flask should be well shaken. Four

hundred to 600 c.c. of the filtrate (at 20° C.) are evaporated to dryness after adding 1 to 3 c.c. of nitric acid. If there is any appreciable amount of organic matter present, the residue is to be carefully charred. Moisten the residue with hydrochloric acid and add 50 to 100 c.c. of distilled water, and then digest. Filter, neutralize with ammonia, add 5 c.c. of strong nitric acid and 15 grams of nitrate of ammonia in solution. Complete the determination according to one of the official methods given for the determination of phosphoric acid, or use the Goss method as given in Circular No. 4 to accompany Bulletin No. 46.

III.—Determination of the Available Phosphoric Acid in Soils by Means of a One Per Cent. Solution of Citric Acid (Dr. B. Deyer).

Preliminary Treatment.—Twenty grams of soil are digested with 200 c.c. of a one per cent. citric acid solution for five hours, at ordinary temperature (18° to 21° C.). The material is filtered and solution is titrated against a standard alkali solution, to determine the amount of acid neutralized by alkalies in the soil. For the estimation of the “available” potash and phosphoric acid, one per cent. citric acid solution has been employed, digesting 100 grams of air-dried soil with 500 c.c. of the solvent, as directed in the preliminary test, corrected for neutralization, for five hours at room temperature. The filtered solution is evaporated to dryness, charred, and the residue abstracted with dilute hydrochloric acid and water. The filtrate from this operation is treated for the determination of phosphoric acid as directed in one of the official methods.

IV.—Determination of the Available Phosphoric Acid in Soils by Means of a Neutral Solution of Citrate of Ammonia.

Ten grams of the soil are digested for one-half hour, at 65° C., with 500 c.c. of strictly neutral solution of citrate of ammonia, specific gravity 1.09. The flask carries a rubber stopper, and is thoroughly agitated every five minutes. At the expiration of thirty minutes, remove flask from bath and filter as rapidly as possible. Wash thoroughly with water at 65° C. Evaporate the solution to

dryness, char, and abstract with dilute nitric acid. Filter and wash thoroughly with water. Burn the residue to a white ash, add it to the solution and bring to complete dryness on sand bath. Take up with hot water and a few cubic centimeters of nitric acid. Digest for one-half hour. Filter and wash thoroughly, and determine phosphoric acid in the solution in the usual way.

Results of Analyses of Soils for Available Phosphoric Acid, by Methods previously described (Soil from Fields of Massachusetts Agricultural College Farm).

NO. OF SAMPLES.	Moisture.	Total Phosphoric Acid.	Available Phosphoric Acid by $\frac{n}{5}$ Hydrochloric Acid.	Available Phosphoric Acid by 1 Per Cent. Citric Acid.	Available Phosphoric Acid by Neutral Citrate of Ammonia.
1, . . .	.77	.255	.0285	.01325	.0735
2, . . .	.87	.290	.0338	.01650	.0945
3, . . .	.95	.210	.0407	.01420	.0865
4, . . .	1.07	.220	.0330	.01920	.0925
5, . . .	1.02	.180	.0345	.01430	.1070

Analysts: HENRI D. HASKINS.

CHARLES I. GOESSMANN.

Conclusion.

The several modes used by us in determining the amount of available phosphoric acid contained in the soil under examination have given different results. The difference in the amount of available phosphoric acid found by any of the modes of analysis employed does not correspond with the actual yield of the several plats in the field. The results of our investigation are more of a suggestive than decisive character. The work will be continued as far as resources on hand will permit.

6. ANALYSIS OF DRAINAGE WATERS OBTAINED FROM FIELD A OF THE HATCH EXPERIMENT STATION.

The field under discussion has been from 1883 to date treated in a systematic way with commercial fertilizers, in the manner briefly described in the following pages. The

field consisted of eleven plats, one-tenth of an acre each, with a space of from five to six feet between the adjoining plats. This space was cultivated in connection with the planted plats, yet received no fertilizing material of any description, nor were they seeded down at any time during the experiment. Each plat was provided in the centre with a tile drain running at a depth of from three and a half to four feet through the entire length, which terminated in an open well, to allow the collection of the drainage water for examination whenever desired, to study the character of the soil constituents carried off. The entire field of eleven separate plats were surrounded by a tile drain with an independent outlet, to prevent an access of drainage waters from adjoining fields. A marked gradual decline in the yield of several plats, in spite of a uniform liberal supply of the fertilizer used during the earlier years of the experiment, rendered an examination into the cause or causes of the reduction in the annual yield desirable.

As an examination of the drainage waters coming from the different plats promised to throw some light on the action of the several mixtures of fertilizers used on the soil resources of the field employed in the observation, it was decided to subject them to a careful chemical analysis. The samples used for these analyses were collected in all cases as far as practicable soon after each tile drain began to discharge drainage water. As the temporary flow of the drains in the different plats differed widely in quantity, no attempt was made to ascertain in each case the exact amount discharged in a given time. The examination was instituted for the purpose of ascertaining the general character of the discharge of the drains, and to determine the *relative proportion of various soil constituents they contained*. The results of this investigation are stated farther on, after a brief description of the general management of the field, as well as a detailed statement of the fertilizers used.

Amount of Fertilizing Ingredients used annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	{ Nitrogen, ...	45 pounds.
	{ Phosphoric acid, ...	80 pounds.
	{ Potassium oxide, ...	125 pounds.
Plats 4, 7, 9, ...	{ Nitrogen, ...	none.
	{ Phosphoric acid, ...	80 pounds.
	{ Potassium oxide, ...	125 pounds.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of the three essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner and as far as practicable on the same day in case of every plat during the same year.

The subsequent tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early in the spring as circumstances permitted. They were well harrowed under before the seed was planted in rows by a seed drill.

PLATS (One-tenth Acre).	Annual Supply of Manurial Substances.
Plat 0, . . .	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, . . .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

PLATS (One-tenth Acre).	Annual Supply of Manurial Substances.
Plat 2, . . .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, . . .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. phosphoric acid).
Plat 4, . . .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, . . .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen) 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, . . .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, . . .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, . . .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, . . .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, . . .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

The above-described course of the general management of the experiment has been followed thus far for five consecutive years (1889-93, inclusive).

Kind of Crops Raised.

Corn (maize), ...	in 1889.
Oats, ...	in 1890.
Rye, ...	in 1891.
Soy bean, ...	in 1892.
Oats, ...	in 1893.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	{ Nitrogen, ... 45 pounds. { Phosphoric acid, ... 160 pounds. { Potassium oxide, ... 250 pounds.
Plats 4, 7, 9, ...	{ Nitrogen, ... none. { Phosphoric acid, ... 160 pounds. { Potassium oxide, ... 250 pounds.

PLATS (One-tenth Acre).	Manurial Substances Applied.
Plat 0, . .	800 lbs. barn-yard manure, 80½ lbs. potash-magnesia sulphate and 77 lbs. dissolved bone-black.
Plat 1, . .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 2, . .	29 lbs. nitrate of soda (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 3, . .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 4, . .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 5, . .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 6, . .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 7, . .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 8, . .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 9, . .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone black (= 16 to 17 lbs. phosphoric acid).
Plat 10, . .	43 lbs. dried blood (= 4 to 5 lbs. nitrogen), 97 lbs. sulphate of potash-magnesia (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).

Analysis of Drainage Water (Per Cent).

100 parts of total solids contain:—

	Plat 0.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.	Plat 7.	Plat 8.	Plat 9.	Plat 10.
Potassium oxide, ...	.600	.380	1.210	.637	.700	.125	.544	2.080	.2740	.5100	.410
Sodium oxide, ...	21.630	23.850	50.180	5.310	16.670	6.290	6.960	20.890	13.6200	25.6400	5.000
Calcium oxide, ...	14.210	10.660	12.090	18.340	21.870	23.070	20.720	22.800	26.1900	20.7700	7.240
Magnesium oxide, ...	6.650	5.390	4.160	5.120	5.340	6.980	4.846	4.680	3.8750	3.9600	2.380
Actual ammonia, ...	.076	.027	.070	.023	.038	.021	.018	.031	.0068	.0100	.025
Albuminoid ammonia, . . .	.525	.043	.108	.185	.077	.302	.338	.068	.0500	.0560	.073
Ammonia as nitrates, . . .	.565	.242	.765	.349	.331	.298	.708	.153	.3920	.0289	.105
Phosphoric acid, ...	trace	trace	trace	trace	trace	trace	trace	trace	.1210	trace	trace
Sulphuric acid, ...	20.260	2.010	22.810	7.920	1.470	52.820	18.970	6.090	5.7500	4.4600	28.530
Chlorine, ...	16.150	26.390	6.040	28.380	38.210	2.420	24.610	35.470	32.0700	36.4100	1.020
Silica, ...	7.700	3.580	.637	4.950	3.160	3.220	5.576	2.570	2.2260	2.8900	.864

Analysts:

HENRI D. HASKINS.
ROBERT H. SMITH.

Drainage Water (Results computed in Percentages).

	Plat 0.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.	Plat 7.	Plat 8.	Plat 9.	Plat 10.
Total solids, ...	.0080500	.0265000	.0182000	.0303000	.0256500	.0248000	.0260000	.0255000	.0530000	.0346000	.0787000
Potassium oxide, ...	.0000480	.0001000	.0002200	.0001930	.0001780	.0000310	.0001415	.0005500	.0001450	.0001770	.0003280
Sodium oxide, ...	.0017409	.0062205	.0091333	.0016100	.0042728	.0015600	.0018100	.0055366	.0072200	.0088740	.0039344
Calcium oxide, ...	.0012441	.0028259	.0021997	.0055600	.0056106	.0057200	.0053880	.0059319	.0138820	.0071880	.0057012
Magnesium oxide, ...	.0005333	.0014272	.0007567	.0015500	.0013693	.0017300	.0012600	.0012396	.0020540	.0013690	.0018738
Free ammonia, ...	.0000610	.0000072	.0000118	.0000070	.0000098	.0000052	.0000048	.0000078	.0000036	.0000036	.0000197
Albuminoid ammonia, ...	.0000420	.0000114	.0000198	.0000562	.0000195	.0000750	.0000880	.0000184	.0000267	.0001064	.0000432
Ammonia as nitrates, ...	.0000460	.0000640	.0001400	.0001060	.0000830	.0000740	.0001840	.0000410	.0002080	.0000100	.0000830
Total ammonia, ...	.0001490	.0000826	.0001716	.0001692	.0001123	.0001540	.0002770	.0000672	.0002383	.0001230	.0001459
Phosphoric acid, ...	trace	trace	trace	trace	trace	trace	trace	trace	.0000640	trace	trace
Sulphuric acid, ...	.0016311	.0005822	.0041511	.0024000	.0003777	.0131000	.0048340	.0016139	.0030500	.0015450	.0224548
Chlorine, ...	.0013000	.0070000	.0011000	.0086000	.0098000	.0006000	.0064000	.0094000	.0170000	.0126000	.0008000
Silica, ...	.0006200	.0009500	.0011600	.0015000	.0008100	.0008000	.0014500	.0006800	.0011800	.0010000	.0006800

Without any intention to discuss here in detail the causes of the variations noticed in the composition of the saline residues left when evaporating a definite amount of the drainage water collected from the various plats, it remains of especial interest to call attention to the fact that wherever muriate of potash had been used as a potash source of plant food exceptional quantities of the chlorides of calcium and magnesium proved to be present (plats 1, 3, 4, 6, 7, 8 and 9). The belief that a liberal use of muriate of potash had resulted in wasting in an exceptional degree in particular the lime resources of the soil, and thereby reducing the yield of the crops, has since been confirmed. The annual yield of the crops has been restored to its former satisfactory condition, after a liberal addition of air-slaked lime to the manures used for years upon the field in question.

REPORT OF THE BOTANISTS.

GEORGE E. STONE, RALPH E. SMITH.

Scope of Work.

Pathogenic Fungi.

Diseases of the Walnut, Maple, Oak, Peach, Plum,
Cherry, Melon, Cabbage, Lettuce, Chrysanthemum and Pansy.

Physiological Disorders.

Seasonal Peculiarities of Certain Shade Trees.

Over-feeding of Plants.

Bronzing of Roses.

Cucumber Wilt.

Some Difficulties which City Shade Trees have to contend with.

SCOPE OF WORK.

This division has during the past year made special effort to come into direct contact with a large number of market gardeners and greenhouse growers; and, largely as a result of this more direct contact and the numerous visits made to their establishments, our correspondence has during the past year doubled that of any other year, and has covered a multitude of subjects relating to botany.

We have paid some attention this summer to the asparagus rust, which caused so much damage in this State in 1897. A study of the conditions which caused the rust has been made at various places throughout the State, and spraying experiments have been carried on in co-operation with different asparagus growers.

The results of the study of nematode worms in greenhouses, which has received a great deal of attention by this division for over three years, have been published in Bulletin No. 55, which can be had on application. This

bulletin, containing 67 pages and 14 plates, gives a full account of the parasitic species of nematode, its life history and development, together with the results of an extensive series of experiments on the methods of controlling the pest. In these investigations the worthlessness of many supposed remedies has been brought out, and a practical method of treatment developed by which the trouble can be successfully and economically avoided. From a considerable amount of data accumulated during the last three years it appears that the loss experienced by cucumber growers who have been troubled with nematodes in the greenhouse equals 25 to 85 per cent. of the marketable crop; and it is hoped, from the positive results obtained, that little trouble may be experienced hereafter with this pest. There are still, however, some further experiments being made upon nematode-control methods, in co-operation with large greenhouse growers, along lines which promise cheaper and efficient results.

The principal investigations with which this division is concerned at present are largely in connection with market-garden crops such as are cultivated in greenhouses. The division is supplied with greenhouses excellently arranged for experimental purposes, and containing space enough to carry on investigations from which reliable deductions can be drawn. The more important greenhouse crops grown in our greenhouses for experimental purposes are those representing considerable importance in this State, namely, lettuce, cucumbers and tomatoes; and it may be justly said that there is no class of agricultural pursuits which is represented by men of greater intelligence, skill and knowledge.

A brief outline of some of the investigations may not be out of place: —

(a) Experiments on the control of the “drop” in lettuce, and a study of the little known habits of the fungus causing the same. A lettuce house, 40 by 12 feet, is devoted to these experiments.

(b) Observations on the “top-burn” in lettuce.

(c) Experiments on the mechanical conditions of the soil, as affecting the growth of lettuce.

(*d*) Sub-irrigation, as affecting lettuce diseases.

(*e*) Experiments on the pruning of cucumbers, in relation to the maturity and production of fruit; also, observations on the various fungous diseases of the cucumber, and the conditions which favor them.

(*f*) Experiments on the pruning of tomatoes, in relation to the production and maturity of fruit; a study of the fungous diseases of the tomato.

(*g*) Experiments on the growth of violets in sterilized soil and nematode-infested earth, with special reference to the relationship existing between the size, maturity and production of flowers in the plants, and abundance of leaf spots.

(*h*) Experiments with gases and chemical solutions for disinfecting greenhouses and repression of fungi.

(*i*) Further experiments on the relationship existing between electricity and plant growth.

There are a host of fungous diseases common to our out-of-door plants, some of which have received special attention, such, for example, as the asparagus rust, aster disease, etc.; but the practice of spraying fruit trees and garden crops has for many years been largely carried out by the horticultural division, which is well equipped with all of the modern spraying appliances.

A few years ago it was generally believed by the majority of people that botany was incapable of being made of any practical use, and it is doing no injustice to truth to state that it did possess little at that time. To-day, however, this state of affairs has entirely changed, and botany, like chemistry and other allied sciences, has taken its place in the industrial arts, — a fact which is due to the advance of science in general, but more especially to the inherent genius characteristic of the American investigator, which naturally emphasizes the utilitarian aspect of science. The annual loss in the United States to agricultural, horticultural and floricultural products caused by pathogenic fungi and their allies will probably equal \$10,000,000. It is, therefore, not only important, but perfectly legitimate, that the principal work of botanists in our numerous experiment stations should consist in studying the life history of these organisms with

a view to their repression. In regard to the industrial side of botany, it should not be forgotten that it owes a great deal to the patient investigations of the many scientific workers of the past, who have devoted their attention to matters of purely scientific interest; and our stations would not be where they are to-day were it not for the labors of these men.

In connection with the characteristic utilitarian features of the present American botanists, it may be of some interest to observe the differences existing between European and American methods of combating pests. Some of the most effective spraying solutions were discovered in Europe, but the methods of applying them and the results obtained by their use to our crops far exceed anything ever accomplished there. To one who has paid any attention to the manner of growing plants in Europe and the methods which are pursued in the control of plant diseases, it would seem no exaggeration to state that more is accomplished in this direction in the United States in one year than in Europe in five years.

The past season has been what might be termed a normal one, although, as in every season, some fungi were especially predominant. There are, however, every year types of fungous diseases which affect our shade trees.

PATHOGENIC FUNGI.

The fungous diseases which have been specially common upon our shade trees this last season are as follows:—

Black Spot of the Maple (*Rhytisma acerinum*, (P), Fr.).

This fungus is characterized by elevated black spots or blotches upon the surface of the leaf, and, while it is not uncommon to a few maples, it has been especially abundant on the silver maple.

Oak Leaf Blight (*Gloeosporium nervisequum*, (Fckl.),
Sacc.).

A fungus apparently identical with that which causes the blight of the sycamore is sometimes found upon the white oak. This produces large dead blotches upon affected leaves, and causes great disfiguration of white oak trees.

Walnut Leaf Blight (*Gloeosporium Juglandis*, (Lib.),
Mont.).

This disease was mentioned in our last report as having been especially abundant during 1897. It has also occurred this year, but to a much less extent.

These diseases are briefly mentioned because complaint has been frequent during the past summer in regard to them, largely, however, from people who possess shade trees which they value. From what we know in regard to the treatment of similar fungi occurring on other plants, it would seem that spraying might hold some of these in check; and the only reply which can be made is, Are the trees valuable enough to receive treatment? Some of these fungi attack large groves, and the expense of spraying would amount to considerable. As a rule, these fungi only make their appearance at intervals, and do not injure the trees to any great extent. In consideration of this fact, it appears questionable to us whether they are worth the trouble; but, should spraying be deemed necessary, it would have to be done early and continued each year.

The disease of the peach known as the "leaf curl" (*Exoascus deformans*, Fckl.) has been unusually abundant during the past season. This disease is well known to most peach growers, causing the leaves to become wrinkled and curled and greatly deformed, finally resulting in their falling to the ground. It is not ordinarily regarded as an especially destructive disease, and does not often cause any appreciable damage to the tree; but, when so abundant as to cause a large proportion of the leaves to fall, it cannot but injure the tree to some extent.

Another disease of the stone fruits, the so-called "plum pockets" (*Exoascus Pruni*, Fekl.), which causes young plants to become swollen and distorted in a peculiar manner, has been received several times this year. Besides the plum (*Prunus domestica*), the wild cherry (*Prunus Virginiana*) is also affected by the same fungus. The disease is not often very abundant, but occasionally causes a considerable diminution of the crop.

For methods of controlling the various diseases of the peach, plum and cherry, consult the spraying bulletin annually issued by the horticultural division of this station.

A Musk-melon Disease.

During the latter part of August our attention was called to a field of musk-melons, in which a destructive disease of the leaves had appeared and seemed to be rapidly increasing. The owner informed us that he had lost his entire crop the year before in the same way. It was evident that the trouble began in the centre of the hills. Here the leaves at the time of our first visit had in many hills wilted and begun to turn yellow and partially died. They were covered with yellow spots, or, in the worst cases, with dead areas of considerable size. At this time the general appearance of the field was good, the only very noticeably affected places being these centres of some of the hills. Still, it could be seen on closer examination that scarcely a leaf in the whole field was entirely healthy. On almost every one there were small yellow spots, more or less abundant, some were slightly wilted, and it was evident enough that the disease was spreading in each hill from the centre outward. The dead areas on the most affected leaves were dry and brittle, marked with slight concentric rings, and a dark, mould-like growth could be seen upon them. Examined with the microscope, this proved to be a fungus, and a species of *Alternaria*. It grew abundantly in the tissue of the leaf as well as upon the surface, where the dark-brown, club-shaped spores were produced. No other fungus or other organism could be found on the affected leaves, and there seemed but little doubt that this was the direct cause of the trouble. Furthermore, Dr. W.

C. Sturgis,* who describes what is evidently the same disease in Connecticut, has succeeded in producing it by inoculating sound leaves with the fungus, thus leaving no doubt that the *Alternaria* is the cause of the trouble. This fungus is a mould-like growth, consisting of a mass of fine filaments which grow upon and in the leaf, consuming its substance and vitality. It reproduces itself by the above-mentioned spores, which are blown by the wind from the surface of the affected leaves to fresh ones, and there germinate and produce the disease. It is not entirely clear why the leaves near the centre of the hill should be the first to show the disease, unless, perhaps, it is because they are the oldest leaves, and thus are growing less vigorously than the outer ones, and less able to resist the attacks of such a fungus. It should not be supposed that the disease spreads outward to the other leaves through the plant itself, as the nature of the fungus shows that this is not the case, but that it spreads entirely by means of the spores which are carried through the air.

As the disease was so far advanced when we first saw it, it was pretty evident that no treatment would be of much avail in checking it. A portion of the field was sprayed with Bordeaux mixture, but the weather continued, as it had been for some time previous, very rainy, and before a second spraying could be made almost every leaf in the field was dead and withered. Some of the melons had reached sufficient size to mature, but nothing like a full crop was obtained. The same disease was met with in one other locality during the season, and no doubt occurred in various parts of the State, though melon-raising is not much practised here. There is no apparent reason why this disease should not be as successfully treated by spraying with Bordeaux mixture as are many similiar ones which are largely prevented by this means. Experiments will be made another season by spraying at the time of blossoming, and several times thereafter during the season. Knowing the nature of

* Report Connecticut Agricultural Experiment Station, 19 (1895), p. 186, and 20 (1896), p. 267. See also Ohio Bulletin 73, p. 235, and 89, p. 117; Journal Mycology, vii, p. 373.

the disease, it will of course be at once understood that it is very advisable to destroy all affected vines and leaves by burning. It might also be safer not to plant melons on land where the disease had already occurred during the previous season. We do not, however, lay great stress on this, as many farmers have a particular area especially suited to this crop, which they do not like to give up, and the disease is probably disseminated widely enough so that it is about as likely to occur in one place as another.

Rotting of Cabbage.

The rotting of cabbage in the field, caused by a species of bacteria, which has recently been so thoroughly investigated by Russell* and Smith,† appeared this year in a field upon the station grounds, and also occurred to our knowledge in several other places in the State. It is a most destructive disease, causing dead spots to appear upon the outer leaves of the cabbage, and usually resulting in a complete decay of the whole head. Cauliflower is quite susceptible, as also cabbages and turnips. A full description of the disease may be obtained in the above-cited Farmers' Bulletin, which can be obtained upon application to the Secretary of Agriculture, Washington, D. C. No practical remedy is known except a rotation of crops. As the disease occurred here on land which had never been in cabbages before, even this seems rather uncertain.

Further Considerations in Regard to the Drop in Lettuce.

We have already referred to this disease in our last annual report, and it may not be out of place to briefly call attention to the progress which has been made towards the control of this troublesome fungus. The study of the organism which causes the disease has given some suggestive results in regard to its treatment. The ordinary "damping fungus" (*Botrytis*), has been generally regarded as the source of the trouble, and we have so referred to it in our previous report. Further observation has shown, however, that, whatever may

* Bulletin 65, Wisconsin Experiment Station.

† Farmers' Bulletin 68, United States Department Agriculture.

be the relation between the drop fungus and *Botrytis*, it is certain that the disease is not spread by *Botrytis* spores in the air, but by a mycelium or mould-like growth in the soil itself.

Our control experiments have so far been along three different lines; namely, those in which chemical substances were used on the soil, the application of various gases to the greenhouse, and the effect of different layers of sand and sterilized earth. The results obtained by the use of chemical substances have been entirely negative, and the use of gases does not at the present time give great encouragement. In our last report we called attention to the use of sterilized soil as a possible control method, and during the past winter and also at the present time this method has been in use. Our experiments have shown that the heating method is the only absolute one, although some gain has been made by the use of three-fourths of an inch of sand upon the beds. The sand which was sterilized showed better results than the unsterilized. In both instances, however, cleaner and better plants have been obtained by the use of three-fourths or one-half of an inch placed upon the surface of the soil. Experiments in which three or four inches of the top soil was sterilized gave absolute results in the control of the drop, and those in which two inches of the infected top soil was sterilized have not as yet shown any evidences of the drop. Where one inch of sterilized soil was used and carefully distributed, the loss from the drop has been about four per cent., while in the adjacent beds which were not sterilized the loss was about fifty per cent. These experiments have been carried out in another badly infested house, managed by an experienced lettuce grower, on a much larger scale, with quite similar results.

While this method gives promise of being a practical one, we are not quite certain as yet whether it is the cheapest one which can be utilized, and other control methods are being experimented with. Some growers clean their houses out every year, and put in fresh subsoil mixed with horse manure; but such a method is expensive, probably more so than the heating of an inch or two of the top soil previous to planting

the crop. If one is provided with a good steam boiler, as most lettuce growers are, probably two hundred cubic feet of soil could be heated sufficiently in one or two hours' time. This amount of earth will cover twenty-four hundred square feet of soil one inch deep, or a bed twenty-four feet wide by one hundred feet long. Of course this heating will have to be done with every crop, as the stirring of the soil subsequent to planting would redistribute the fungus. As a necessary precaution against the drop, it would also be necessary to have all the soil sterilized in which the pricklers are started, and also that which contains the first transplanting. By this means alone much lessening of the drop could be accomplished; but in conjunction with sterilized layers one inch thick in the house, it would in most cases reduce the infection still further. The amount of earth that is employed in the seed bed and also that in which the first transplanting is done is not so large but that it could be entirely sterilized. When this is once accomplished, it would be sufficient for some time to come, provided precautions were taken against outside contamination. The benefits gained from the use of sterilized soil are in themselves, regardless of the drop, sufficient to pay for the process, according to some who have used it, inasmuch as the lettuce plant shows a better color and makes a quicker and larger growth.

The Chrysanthemum Rust.

This comparatively new disease has been not uncommon in the State during the past season; but it is encouraging to note that its attacks seem in most cases where it has occurred to have had but little appreciable effect, and the indications now are that this disease is one which may be fully controlled by proper methods of cultivation and management. We noticed especially a case where a lot of plants were brought in in August to set out in the open bed for fall blooming. Fifteen plants were left over, and remained standing on a greenhouse bench in pots. Later in the season this bench was filled up with other potted plants which had remained out of doors. Though all were of the same lot, the fifteen became badly rusted, while none of the others or

those set out in open beds showed any signs of the disease. It seemed pretty evident, therefore, that the high August temperature of the house had a bad effect upon the plants confined in pots, causing them to be more susceptible to the disease. Some of the plants which were still out of doors in a cold frame also became rusted, but these were crowded together so that all the lower leaves had fallen off, and were plainly in poor condition. Of the many plants which were set out in open beds in August or placed on benches with space between them in September, not one showed any noticeable rusting.

It remains to be said that the rusted plants, though badly affected, produced blossoms as good, apparently, both in quality and quantity, as similar healthy plants, and, furthermore, did not spread the disease to other plants, though kept in close proximity to them. Judging, therefore, from this year's experience, it seems probable that the skilful gardener has no great cause for apprehension in this disease.

A New Pansy Disease.

During the past summer our attention was called to a field of pansies at the establishment of a local seed grower, in which the plants were badly affected by a disease of the leaves and blossoms. Upon the affected leaves first appeared small dead spots, each surrounded by a definite black border. These spots soon increased in size, and in the later stages of the disease the affected leaves had an appearance very similar to that of the violet leaf spot (*Cercospora Viola*, Sacc.). Many plants were killed outright by the disease, and all affected ones were in very poor condition. Besides the spotting of the leaves, many of the blossoms also were affected, the petals being disfigured by dead spots and blotches upon them, while some of the flowers were malformed or only partly developed. The latter was indeed one of the most serious features of the trouble, as the plants were raised for seed, and the yield was greatly reduced by this failure of the blossoms to develop properly.

It was thought at first, from the general resemblance of the leaf spots and close relationship of the two plants, that

this might be identical with the violet disease. This, however, did not prove to be the case. Examination showed that the cause of the trouble was a fungus, but one of quite a different nature from *Cercospora*, and belonging to the genus *Colletotrichum*, being apparently a new and undescribed species. This form has therefore been described in the "Botanical Gazette" of March, 1899, under the name *Colletotrichum Violæ — tricoloris*.

This same disease has been seen in a few other localities in the State, and Prof. B. D. Halsted has also very kindly sent us specimens of it from New Jersey, so that the trouble is doubtless widespread. Its occurrence, however, seems to have been comparatively slight, except in the one instance described above. In this case the number of plants was very large, and pansies had been grown upon the same field for several years, which may account for the severe outbreak of the disease.

A portion of this field was sprayed twice with strong Bordeaux mixture; but, as it was already late in the season, and heavy rains prevailed at the time, little success from the treatment was looked for. The owner, however, thought that a beneficial result appeared from the treatment, and from our own observation we can claim at least that later in the season the sprayed portion of the field was certainly in the best condition of any. If this did indeed result from the spraying under such adverse conditions, it seems likely that the disease could be kept well in check by proper treatment.

PHYSIOLOGICAL DISORDERS.

Seasonal Peculiarities of Certain Shade Trees.

Some complaints have been made in regard to the falling of leaves on the elm, maple and apple trees. This was especially noticeable on the elm in various sections. We had many specimens sent in for examination, and our attention was called to a number of trees in which certain branches had only half-developed leaves on them. These leaves would linger along a while in this condition, when they would gradually turn yellow and drop to the ground.

Examination made of a great many leaves and branches revealed no fungous or insect pest preying upon them. The condition of the apple trees was similar, although not so prevalent; and in the maple the cast-off leaves were mature ones. The exact cause of this trouble is not obvious, but there can be little doubt that it was a functional disorder. We have observed fine specimens of elm trees, which, after a period of excessive seasons, would suddenly lose all their leaves in midsummer, yet a year or two later would appear as vigorous as ever. Inasmuch as the trees are not materially injured by the falling of a few leaves in midsummer, remedial measures are not necessary.

Over-feeding of Plants.

The over-feeding of plants is not an uncommon occurrence at the present time, when so much concentrated fertilizer is used, and where attention is not given to the proper amounts that should be employed. This trouble not only occurs among florists, etc., but among those who cultivate house plants as well; and the cause of the trouble is usually traceable to the fact that most people are not aware of the strength of the constituents serving as plant food. The normal strength of chemically pure solutions, available for plants, is about one to one thousand or one to two thousand parts, and when these solutions are put on at the rate of one to one hundred or so, ill results must be expected to follow their use.

We now and then have specimens of abnormal plants sent in to us which are merely suffering from some such treatment. A potted specimen of a Johnsonian lily, which had a number of reddish eruptions or blisters upon its leaves, was sent in for examination. These reddish blisters were examined under the microscope, and they showed no evidence of fungi or insects being present. The cells, however, in the vicinity of the blisters showed that they had been stimulated exceedingly, which manifested itself in excessive cell division, giving rise to the blisters; and where this action had taken place excessively the tissues were ruptured, thus producing a ragged, wounded appearance. This trouble

could be readily referred to some abnormal features in connection with nutrition, and an inquiry showed that the plants had been heavily fertilized with Chili saltpetre. The same treatment was applied by us to a perfectly healthy Johnsonian lily, with the result that the same activity was shown in the division of the leaf cells, which subsequently gave rise to blisters or ragged eruptions identical with those described.

A number of potted specimens of cyclamens grown by a florist were also brought to our notice last winter, which showed somewhat similar peculiarities in the leaf. These leaves were blistered, although in quite a different manner from the Johnsonian lily mentioned above. There were no ragged or lacerated eruptions or pustules on the cyclamens, and the manner of blistering was quite different, although it was evidently caused by over-feeding, or at least by injudicious feeding, as it was found that the plants had been heavily treated with nitrate of soda.

A singular case of over-fertilizing or perhaps over-watering was seen in some specimens of carnations sent in to us by a grower. We subsequently visited the greenhouse where they were found, and had an opportunity of seeing these abnormal plants in the benches, beside other plants of the same variety that were not affected. About fifty plants in this house showed this trouble, and it was confined to the most robust specimens of the variety known as the Edith Foster, and in some instances to the Mrs. Fisher. The characteristics of these diseased plants were whitish stems and foliage, which were enlarged to about twice the size of normal ones growing next to them. Repeated examinations of the tissues of the affected plants seem to show that there was nothing the matter with them except what might be expected from improper nutritive conditions, such as might be brought about by too much fertilizer or excessive watering, which caused the plants to be stimulated abnormally in their growth. In the spring the plants were removed from the greenhouse into fresh garden soil, but they failed to recover. The same variety of carnations has already shown similar symptoms this season.

Injudicious use of fertilizers is not an uncommon matter,

and more care should be exercised in their application. Most fertilizer companies give explicit directions as to the amounts which should be employed, and the excessive use of them is generally traced to the carelessness of the gardener in applying them. The results of over-feeding generally manifest themselves in some abnormal stimulation to the plant; but these results, even when the same fertilizer is used, do not show themselves in a similar manner on different species of plants. What would give rise to a multiplication of cells and the formation of blisters in the leaf of one plant, would not do it in the leaf of another. In short, stimuli in plants manifest themselves specifically and manifoldly.

The Bronzing of Rose Leaves.

A peculiar bronzing or irregular spotting of rose leaves was brought to our attention last winter by Mr. Alexander Montgomery, Jr., a member of the senior class. This peculiarity in the spotting or bronzing of the leaf is common to grafted varieties of the Tea, Bride and Bridesmaid roses, grown at the extensive Waban conservatories at Natick; and Mr. Montgomery, who was working in the botanical laboratory at that time, made, at my request, some investigations into the cause of the trouble. Both Mr. Montgomery and his father, who is in charge of the Waban conservatories, have had ample opportunity to observe bronzing; and it therefore became a very easy matter to secure valuable data. The only mention which we have noticed in connection with this disease is that given by Professor Halsted of New Jersey, who briefly referred to it in his annual report of 1894.* In this report he gives a figure of the black spot of the rose, and in connection with it is shown what he designates a "discoloration that is most frequently met with on the foliage of the La France, and may be called bronzing." This he states, so far as he knows, is "not due to any fungus, and is likely due to a structural weakness." This reference to the disease by Professor Halsted was not observed until Mr. Montgomery had finished his investiga-

* New Jersey Experiment Station Report, 1894, p. 384.

tions; and, in order to ascertain whether the trouble with which we were concerned was the same which he had briefly alluded to, we forwarded him specimens for examination, which resulted in establishing the identity of the two. There is a certain resemblance between the spots which give rise to bronzing and those which are caused by the black spot; and we found that the impression prevailed among some rose growers that bronzing was simply an immature stage of the black spot. To any one thoroughly familiar with the characteristics of both diseases, the differences between them would be evident, and they would not be likely to confound one with the other.

The investigations of Mr. Montgomery showed that the abnormal condition of the rose leaves subject to bronzing was not in any way connected with fungi, but is of a physiological nature, or structural weakness, as Professor Halsted had correctly surmised. The first symptoms are manifested in a mottled, bronzing coloration of the leaf. These spots subsequently become more prominent, ranging from one-sixteenth of an inch to one inch in size; the infected portions of the leaf frequently turn yellow, and eventually the leaflets and leaf stalk drop to the ground. Sometimes, however, a whole leaflet becomes bronzed, and the yellowish color is not observed. Numerous microscopic cross-sections made of the bronzed leaf spots showed that the epidermal and adjacent cells were in an abnormal condition. The living contents of the cells were disintegrated, the protoplasm and cell walls had turned a reddish-brown color, and numerous very minute bodies about the size of micrococci filled the affected cells. These minute bodies proved upon examination to be crystals of calcium oxalate. The excessive deposits of calcium oxalate indicate that the leaf cells, being unable to obtain sufficient nourishment, were not able to assimilate the calcium salts, and consequently it is deposited in the cells in the form of calcium oxalate. It may be said that all of this phenomenon is nothing extraordinary, but merely concomitant with the death of the leaf, and can be observed in other species of plants. Mr. Montgomery states that the bronzed leaves are more susceptible to disease,

and he has observed the occurrence of rust upon them, while healthy leaves would be entirely free.

A further examination of the affected plants at the Waban conservatories, made by Mr. Montgomery and myself, showed that all leaves even of plants subject to it were not affected, but that it was confined in every instance to two places: first, where a stem is cut and a new branch starts, the leaf at the base of the branch begins to bronze; second, when an eye or axillary bud is rubbed off, the leaf generally becomes bronzed.

There is a difference in susceptibility between young plants and old ones. Roses planted in the middle of June show bronzing the first of August, but it is scarcely noticed after the first year's growth. Bronzing appears to occur more largely upon plants which show rapid growth than on those which have grown more slowly; for this reason apparently the root plants or ungrafted ones at the Waban conservatories which are not so vigorous as the grafted ones are not susceptible to it. Bronzing sometimes occurs upon small, weak stock.

It should be stated, however, that, since bronzing occurs on leaves at the axils of the shoots which bear the flowers, no real harm is done to the marketable foliage, as the cutting of the flower stalk is always above the position of the leaves which are bronzed. The most intelligent and successful rose growers always take the most care and pride in their plants, and they are suspicious of any abnormal feature which in any way mars the beauty of them; and this is, so far as we have observed, the only inconvenience which this trouble of bronzing gives rise to.

It is quite evident that we have in the bronzing of rose leaves a physiological phenomenon which is not uncommon to other plants. We have observed a similar falling of the axillary leaves in other species of plants. In the rose it is probably a correlative phenomenon, which is brought about, or at least augmented, by years of cultivation and development along certain lines. Any form of mutilation, whether it be a cut or a mere scratch, acts as a stimulus to a plant; but the manner of reaction of the plant may not always be

the same either in kind or degree. As a rule, the cutting of primary organs, such as a shoot, will give rise, among other things, to increased activities in the secondary organs, such as a side shoot or side root; and conversely the cutting of a secondary organ or branch will stimulate the primary organ or main shoot. Then, again, the effects of stimuli caused by cutting are more marked near the source of injury, and less marked the further away an organ is from it. For example, the cutting of the main axis near an eye or bud would give rise to increased activities in the axillary bud, which would manifest itself in the development of a new shoot. The nearer the cut to the eye or bud, the more marked will be the stimulation, or resultant activities, and the more completely will it assume the characteristics of the primary shoot. The better condition the plants are in, and the more suitable and available plant food with which they are supplied, the more rapid will be the growth of the shoot, and the more marked will be the correlative effects. Such, in fact, are some of the laws governing correlation in plants.

In the case of the bronzing and subsequent death of the axillary rose leaves, the stimulative effect of cutting causes a marked growth of the shoot, and the nutritive substances are thereby utilized by this organ to such an extent that some other portion of the plant is made to suffer. In this instance it is the axillary leaf which finally becomes bronzed, turns more or less yellow and dies. In other words, bronzing is nothing more or less than a physiological disorder, and falls under the domain of plant irritability.

Cucumber Wilt.

The growing of cucumbers under glass is carried on extensively in some places in this State, and a disease known as the wilt has been reported to the station a number of different times. Complaints in regard to this disease have always come from certain localities where it has, as a rule, been quite universal among the different growers. The symptoms of the disease are a wilting of the plant, or, more strictly speaking, of the foliage, whenever it is subjected to the intense rays of the sun.

We visited several cucumber houses this last spring in which the plants were subject to wilt, and observed a number of houses which contained badly affected plants. In those houses running north and south, the vines in the morning on the east side, which are subject to the sun's rays, would be entirely wilted; while those on the west side, and away from the sun's rays, were not in the least affected. In the afternoon, when the sun had reached the west side of the house, the vines would then become badly wilted, and those on the east side, when no longer exposed to the direct rays of the sun, would commence slowly to recover. The cause of the wilt in every instance was not difficult to understand; but, as a necessary precaution against drawing deductions too hastily, we examined every portion of a number of plants very carefully, to convince ourselves that there was no other cause than that which we had in mind. It is well known that there is a bacterial disease of cucumbers that gives rise to a wilting of the leaves, but careful examination of the tissues shows nothing in the nature of bacteria to be present.

At about the same time we visited several other cucumber growers in other sections of the State, and had an opportunity of examining many vines in about the same stage of development. In some instances the identical varieties of cucumbers were grown, but in the majority of cases another variety was used, namely, the White Spine, and in all cases the methods of cultivation were radically different, and the wilting of the vines was something unknown to them. Long before we visited the region of wilt a number of letters of inquiry had shown us that the disease in question was local, and the majority of growers had never had trouble with it.

The cause is not due to any organism, whether insect or fungous, but to extremely abnormal conditions of the plants, brought about by irrational methods of cultivation that give rise to defective transpiration, or, in other words, to the giving off of water from the leaves. The activity of transpiration is affected by various causes. It is well known that the stomata or breathing pores of the leaf are open during sunshine and closed during darkness, and that the greatest

activity in transpiration takes place during sunshine. This fact is frequently demonstrated by young cucumber plants in tolerably good conditions of health, which not infrequently show some indications of wilt in sunshine, though not enough to cause any amount of harm. This is especially so when they are forced too rapidly, and when the texture of the leaf is not sufficiently developed. The temperature of the air affects transpiration. A plant in an atmosphere saturated with moisture will not exhale any watery vapor, provided that the temperature of the plant is not higher than that of the air; but when the temperature of the air is high, and the proportion of moisture small, transpiration is promoted. Transpiration is further affected by the temperature of the soil in which the roots are embedded. When the roots are warmed, transpiration becomes more active, and consequently there exists more root absorptive activity. The nature of liquids which the roots absorb and the kind of soil in which they grow also affect transpiration. Plants transpire more when grown in sandy soil than when grown in clay soil; also when grown in acid soil than when grown in alkaline soil. One per cent. solutions of potassium nitrate and other salts diminish transpiration, and we have been able to produce severe cases of the wilt by watering pots of cucumber plants with a one per cent. solution of potassium nitrate.

The wilt, however, in the houses mentioned before was not due to temperature or constituents of the soil, but was brought about, as we have already inferred, by irrational methods of treatment of the plants, and depends upon other causes. In all probability, the cause of the wilt may be attributed partially to the characteristic peculiarities of the varieties of cucumbers grown, as most of the varieties are Telegraph or Giant Pera. In many cases hybrid forms are obtained by crossing these with the White Spine. These varieties present a different appearance from the White Spine; their stem and leaves appear to be small, and the plants do not appear normally as green and rugged as the White Spine.

The methods of growing cucumbers where the wilt occurs

are radically wrong in many ways. The houses are imperfectly supplied with ventilation, consequently little use can be made of this necessary feature. Then, again, they are supplied either wholly or partially with two layers of glass, which are set about two inches apart, thus leaving an air space in between for the purpose of keeping out the cold, but which in reality becomes filled up with dirt, and is an excellent aid in shutting out the light. Plants started in such a house in winter continually suffer from lack of light, — a feature which we have often observed in the greenhouses in this State. Their leaves become pale, and they are attached to the stalk by means of elongated petioles, and present all the phenomena of partial etiolation, or, in other words, they resemble plants grown in the dark. If we add to such plants an enormously high temperature, without any proper ventilation to make them stocky and rugged, then we have a crop that is so tender and abnormally matured that it is incapable of standing strong sunlight. If such a crop is carried over until spring, and subjected to the intense rays of the sun occurring in that season of the year, the tender, etiolated, sickly colored leaves commence to wilt even with the house closed and a considerable degree of moisture.

We observed as many as a dozen houses last spring affected in this way, and not in a single one did we see more than a dozen or so of what might be termed fairly good-colored and healthy plants. Whenever we observed a plant which possessed any color or texture in its leaves, we found plants which showed no indication of the wilt. We examined at the same time in another locality a crop of a similar variety of cucumbers grown in a house provided with a single layer of glass, which had also received sufficient ventilation, and the plants were in an exceedingly vigorous condition.

These facts show what it is always necessary to bear in mind, that some varieties of plants can be grown by different growers with entirely different results, and that it is essential to pay the greatest attention to conditions which are normal to the plants.

While the cause of the cucumber wilt is due, as we have

already pointed out, to irrational methods of greenhouse management, the specific cause can be traced directly to the lack of texture in the plants, brought about by too high a temperature and lack of light in the beginning, which does not enable them to stand up under the powerful rays of the spring sun, as the amount of water thrown off from their tender leaves is more than can be supplied by their roots. This irrational method seems to have its origin in a desire to save coal, and starve the plant by utilizing double layers of glass, and to indulge in too much forcing; or, in other words, to get more out of the plant in a certain length of time than its inherent capacity warrants. In these methods of culture, affecting, as they do, a single locality, we see nothing but practice based upon a disregard of the normal functions of the plant, and mistakes due to local conception of greenhouse management. The remedy in such a case is obvious, and consists in giving the plants during their young stage of growth plenty of light and air, and not allowing them to grow too rapidly. Cucumber plants grown in this manner will possess color and texture, and they will be capable of standing the spring rays of the sun without wilting.

Some Difficulties which City Shade Trees have to contend with.

For some years back our larger cities have had park commissions, whose duty consists, among other things, in seeing to the setting out and caring for shade trees. Many of these cities, having seen the necessity of a more general oversight in regard to the care of trees, have gone a step further, and have secured the services of a trained forester, whose business it is to pay special attention to their welfare.

This department frequently has specimens of diseased leaves and branches, especially of trees, sent to it for the purpose of determining what is the matter with them. Sometimes these specimens are from trees in which a single branch has lost its leaves in mid-summer, or they may be specimens from a tree which has died suddenly. An examination of the specimens frequently shows that there is no reason for believing that their abnormal condition is caused

by either insect or fungi, although at times there may be observed a few aphids on them, which it is generally supposed are the cause of the trouble. The causes of these troubles, however, are in many instances to be traced to conditions which are peculiar to our times. In this age of electric lights, trolley cars, sewers, pavements, gas, and transmission of steam for heating purposes, it must be confessed that the practice of setting out shade trees along the borders of streets in our cities becomes rather discouraging. The price of enjoying these modern appliances of scientific thought means more than the mere cost of digging up our city streets and lopping off the limbs of trees every few months; in many instances it means the death of many shade trees, and it may eventually lead to the question whether it is worth while to bother at all with trees for our city streets. The sickly, disfigured, mutilated specimens of trees which are now and then seen in our busy city streets have very little to recommend them, and in many cases thoroughfares would become improved without them.

Some of the agencies which more especially affect our trees are electricity, gas and steam. These may affect the tree directly, by escaping and coming in contact with some portion of it, or indirectly as by the lopping of limbs for wires or the digging of trenches for the pipes, which very frequently results in destroying portions of the root system. There are other agencies, however, which are associated with the death of the tree. One of these is the borer that is very troublesome to the rock maple. Trees affected with these can be readily detected by an examination of the bark of the tree for round holes about one-quarter of an inch in diameter, and in autumn the affected limbs can be readily detected by a premature coloration, or hectic flush, as it were, of the leaves. Then, again, there is the work of horses' teeth, which, according to Mr. James Draper, who has had many years' experience as a park commissioner at Worcester, inflicts more damage than any other single thing to city trees. Many of the specimens of diseased shade trees which are sent in to us year after year can be referred to one of the above agencies as a cause of the trouble.

The death of many trees can be referred to illuminating gas. If a leak occurs in the pipe, the gas escapes very readily into the soil, especially if it is porous, and when it comes in contact with the roots they are asphyxiated, and the result to the tree manifests itself very quickly. The symptoms of gas poisoning are most generally a sudden falling of the leaves, a deadened appearance of the bark, due to the collapse of the cambium or living layer, brought about by the asphyxiation of the roots, which results in the rapid death of the tree. In mild instances of poisoning the effect shows only upon one side of the tree, but in general the tree seldom escapes death. We have observed many single trees killed by gas on the private grounds of city residences, without the owner ever surmising what the trouble was; and this last summer we had an opportunity to examine whole rows of native trees which had died by gas asphyxiation. Some of the trees which we observed were at a distance of fifty feet from the nearest gas main, while others succumbed when not nearer than one hundred feet to the leak in the pipes. While it is advantageous to all gas companies to stop these leaks as soon as they are found, it becomes practically impossible to do so in every instance, and the death of trees from this source must constantly be expected. As a matter of fact, the death of some fine shade tree is not infrequently the first indication the gas company has of a leak in its main.

Abnormal respiratory conditions, which usually result in either a sudden or lingering death to trees, occur where they have become submerged in water, or where they have been covered with a foot or more of soil. We have noticed trees growing beside sloping roadsides which had become filled in with earth only on one side of the tree, resulting in that side of the tree becoming dead, while the other side would linger along in an unhealthy condition for years.

Less often does the death of trees result from steam, as the transmission of this is not so common. Occasionally, however, where steam pipes are laid near trees, they are sometimes injured.

The various forms of concrete and pavements and the large

surface of the ground covered by them about the city streets are a menace to the health of trees, and the sickly conditions which they present are often due to these. Some of our more modern city streets obviate this matter by leaving a wide space of turf between the sidewalk and road, for the purpose of planting trees. This gives the roots a chance to develop normally, inasmuch as the respiratory functions are not interfered with, as is the case when they are covered with pavements. Many of the streets in Springfield are especially commendable in this direction.

Not a little of the disfiguration of trees is directly due to the linemen in lopping limbs, and more especially to the direct effect of electric currents. We have observed no instance where electricity has killed a tree outright, but there are many cases where the limbs have been killed by burning. This effect is not only caused by the alternating current of the electric lights, but by the direct current of the trolley system; the latter current being probably more injurious, provided the same amount of amperes and voltage is employed. The damage done by grounded wires takes place when trees are moist, as at that time the resistance is reduced, and the current becomes increased and has a better opportunity to become dispersed. We have known of instances where trees and the grass for some distance about them have been charged with the escaping current. The damage to the trees, however, is due to the heating effect of electricity. The wire becomes grounded on a limb, and when moist the current escapes. At first comparatively little current passes through the limb, as the resistance is high; but, as the heat increases the resistance decreases, with the result that a large amount of current passes through, which gives rise to still more heat, and subsequently develops into a blaze. The action of electricity, as we have already stated, is local in its effects. The injury, while sufficient to kill every portion above the limb or trunk, does not, so far as our observation goes, destroy the tissues very far above the point of grounding. There are reasons for believing, however, that the effects of the direct current are more severe than those of the alternating current. In the case of

the alternating current the anode and cathode alternate very quickly, while in the direct current no alternation takes place, and this results in an electrolysis of the cells, which in turn produces disintegration and quick death to the protoplasm. In short, we may say that all of the injury to trees by electricity is brought about by heating, and by electrolysis and disintegration of the cell contents. Some observations made by Professor Hartig of Munich upon the effects of lightning on trees are interesting in connection with the subject of electricity. He observed that when a tree is struck by lightning the current usually travels along the cambium zone or living layer of the tree, just under the bark, inasmuch as at this point the current finds the least resistance. Sometimes the burning effect is more marked just inside and outside of the cambium layer, where the resistance is slightly greater, — a feature which is shown by the dead areas in the trees many years after. There are many trees struck by lightning which show scarcely any injury, and others will show only a small dead area which coincides with the path of the current. Professor Hartig has made many observations upon trees struck by lightning, and his practised eye is able to detect trees that have been so affected which to the ordinary observer would appear perfectly sound.

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